Project Acronym:	PhasmaFOOD
Grant Agreement number:	732541 (H2020-ICT-2016-1 - RIA)
Project Full Title:	Portable photonic miniaturised smart system for on-the-spot food quality sensing

DELIVERABLE

Deliverable Number	**D7.6**
Deliverable Name	**Final project report on dissemination and exploitation**
Dissemination level	PU - Public
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WP / Task responsible	WP3 / INTRA
Keywords:	Dissemination, Communication, events, website, Social Media, dissemination material, publications, collaboration activities, standardization.
Abstract (few lines):	This deliverable presents a detailed report on the progress towards the implementation of the dissemination strategy and plan for the period M19 - M36 (end of the project), outlines the overall project exploitation and innovation activities for the same period and provides the updated Data Management Plan.

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Approved by:	Spyros Evangelatos (INTRA)

Summary

In the present deliverable, we provide a detailed report on the progress towards the implementation of the communication/dissemination strategy and the plan presented in the deliverable D7.3. We also outline the detailed project exploitation and innovation activities. The purpose of this deliverable is to document PhasmaFOOD's dissemination and exploitation activities during the project´s period running from M19 (July 1, 2018) to M36 (December 31, 2019). This deliverable is the second deliverable update within WP7 which follows D7.4 the Mid project report on dissemination and exploitation.

The major dissemination means, channels and procedures used by PhasmaFOOD have been thoroughly defined and described in the dissemination plan and include both "conventional" approaches, such as participation in events, publications/journals, printed material production and Web 2.0 related activities.

The dissemination material has been produced by the PhasmaFOOD consortium in alignment with the project's objectives and according to the project's specific needs. PhasmaFOOD's extensive use of online dissemination is also summarized together with quantitative and qualitative analytics, showing the use of both the PhasmaFOOD website and the relevant Social Media channels.

The detailed project exploitation plan and strategy, technology transfer directories, project impact and innovation outcomes have been prepared and outlined in the deliverable D7.5.

Last but not least, the deliverable D7.2 "Data Management Plan" has been updated as planned and included in full as an Annex II in this deliverable.

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

Document History			
Version	**Date**	**Contributor(s)**	**Description**
V0.1	18/10/2019	INTRA	ToC created.
V0.2	25/09/2019	INTRA	Initial draft, including initial content for each chapter.
V0.3	3/12/2019	VLF	Input from VLF included.
V0.4	9/12/2019	WINGS	Input from WINGS included.
V0.5	11/12/2019	INTRA	INTRA additions/modifications and final version for internal review.
V0.6	17/12/2019	VLF, WSFR	Further input and revisions by VLF and WSFR included.
V0.7	18/12/2019	CNR, AUA	Further input and revisions by CNR and AUA included.
V0.8	19/12/2019	INTRA	Finalisation of the document.
V0.9	20/12/2019	INTRA	Final document.
V1.0	24/12/2019	INTRA	QA and submitted version.

Table of Contents

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

Table of Figures

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

List of Tables

Definitions, Acronyms and Abbreviations

Acronym	Title
CO	Confidential, only for members of the consortium (including Commission Services)
CR	Change Request
D	Demonstrator
DL	Deliverable Leader
DM	Dissemination Manager
DMS	Document Management System
DoA	Description of Action
Dx	Deliverable (where x defines the deliverable identification number e.g. D1.1.1)
EIM	Exploitation Innovation Manager
EU	European Union
FM	Financial Manager
MSx	project Milestone (where x defines a project milestone e.g. MS3)
Mx	Month (where x defines a project month e.g. M10)
O	Other
P	Prototype
PC	Project Coordinator
PM	partner Project Manager
PO	Project Officer
PP	Restricted to other programme participants (including the Commission Services)
PU	Public
QA	Quality Assurance
QAP	Quality Assurance Plan
QFD	Quality Function Deployment
QM	Quality Manager
R	Report
STM	Scientific and Technical Manager
TL	Task Leader
WP	Work Package
WPL	Work Package Leader
WPS	Work Package Structure

1 Introduction

1.1 Purpose and scope

The present deliverable has been prepared in the context of Work Package 7 "Dissemination & exploitation activities". WP7 is a horizontal component within the project work plan. It aims at supervising the integrity and consistency of all dissemination efforts for creating awareness on the PhasmaFOOD sensor node among the relevant stakeholders operating in the areas of smart systems, IoT, Wireless Sensor Networks, advanced electronics, MEMS, photonics and spectroscopy, as well as investors, policy makers, scientific/research communities and general public. It also aims to drive the project policy towards handling of relevant research data as well as to support commercial exploitation and industrial transfer of project's outcomes.

The purpose of this manuscript is to document the PhasmaFOOD dissemination and exploitation activities during the period from M19 (July 1, 2018) up to M36 (December 31, 2019). Indicative categories of such activities include:

- Dissemination activities:
  - Web-based dissemination activities (website-related and the Social Media)
  - Events-based dissemination activities (participation to the events and workshop organization)
  - Publications/Journals (scientific publications and articles)
  - Scientific Posters presented in various events
  - Newsletters and Press Releases
  - Paper-based dissemination activities (extensively used for dissemination & communication purposes)
  - Collaboration with other projects & initiatives

  Those means have been used by the consortium to promote the concept and achievements of PhasmaFOOD project during the second half of the project towards selected stakeholders and multipliers, such as the research and scientific community, the industry, the EC and relevant research projects and a wider public and end-users.

  In the present deliverable, we provide the detailed, final report on the results towards the implementation of the communication, dissemination and exploitation plan, presented in the deliverables D7.3 and D7.4.
- Exploitation activities
  - Project exploitation exploitable results
  - Technology transfer strategy
- Innovation and Impact activities
  - Report on the innovation and impact activities of the project
  - Market outreach activities
  - Scientific and technological impact of the project

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

- Data Management Plan – update

A detailed report of each activity is presented within each category (as above).

1.2 Structure of the Document

The following Sections of the deliverable at hand are organised in the following manner:

Following **Section 1** (which serves as an introductory section), **Section 2** provides a report on the dissemination and communication activities that took place during the second half of the project.

Section 3 outlines the updated plan regarding the exploitation and innovation activities of the project consortium.

Section 4 introduces the updated Data Management Plan, which is provided in full in Annex II of the present deliverable.

Finally, **Section 5** concludes the document.

2 Report on Communication and Dissemination activities

2.1 Web-based Dissemination

2.1.1 Project website

PhasmaFOOD website is accessible at www.PhasmaFOOD.eu and it has been maintained as the main communication tool for diffusing the dissemination and communication of information related to the project. The PhasmaFOOD website has been a single gateway to access available results for all the general public and all relevant stakeholders looking for information.

The site will be maintained for at least two years after the completion of the **PhasmaFOOD** project.

Overview

Information regarding the technical details and content organisation can be found in the deliverable D7.1 "Project website".

The website has been regularly updated, particularly in terms of its structure and contents (news, events, outcomes, publications and downloads), following the project's developments and in order to ease users' navigation.). In addition, a new tab showing the "Clustering Activities" with project and initiatives has been added.

Website analytics

From the figure below taken from the google analytics covering from M19 up to M36, we can observe the following:

- Number of unique visitors on the site: **5.754**
- Number of sessions[1]: **6.449**
- Number of page views: **8.871**

[1] Session: the unique visit of a user on the site, navigating over one or more pages. A new session starts if the user has not access a new page of the site for more than 20 minutes.

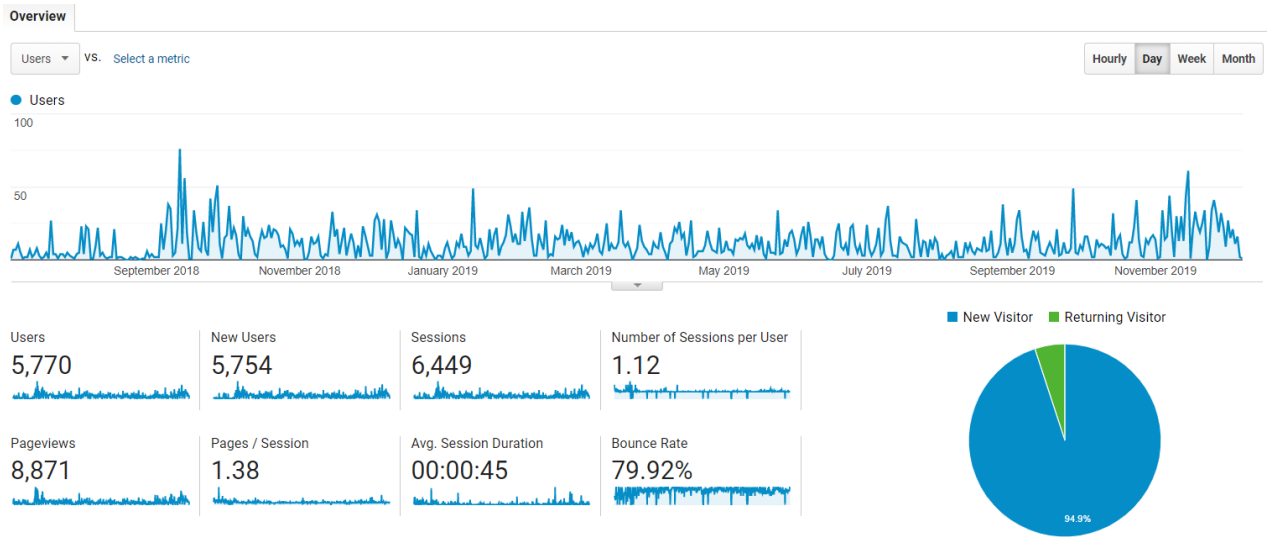


Figure 1: PhasmaFOOD Website Analytics – Overview (M19-M36)

From the figure below taken from the google analytics covering the whole duration of the project (M1-M36), we can observe the following:

- Number of unique visitors on the site: **7.344**
- Number of sessions[2]: **9,624**
- Number of page views: **19.890**

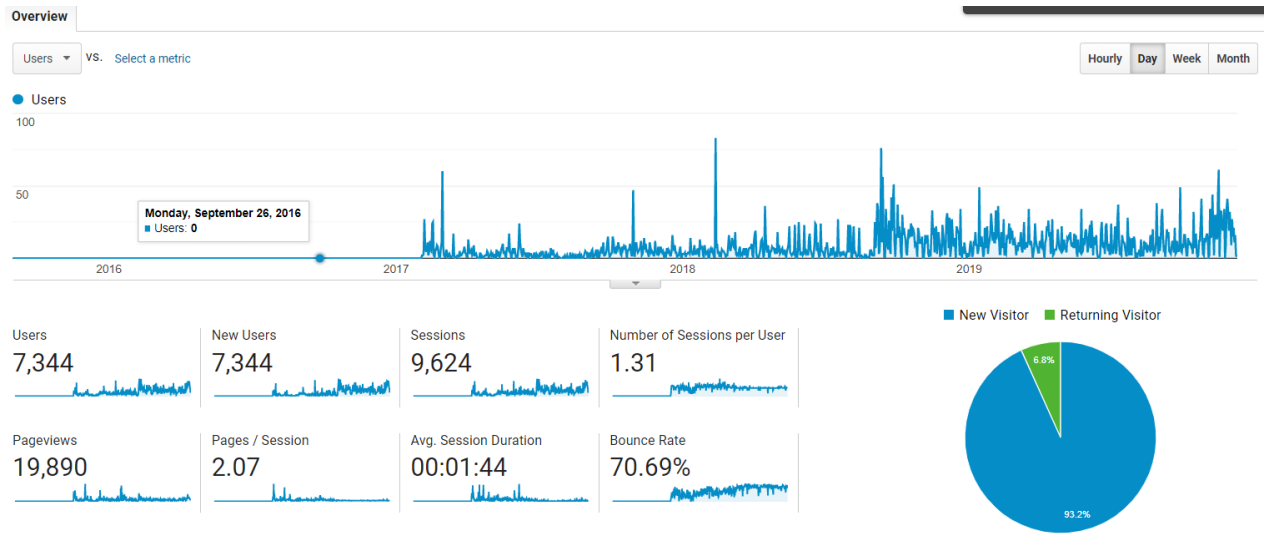


Figure 2: PhasmaFOOD Website Analytics – Overview (M1-M36)

The peeks of users' activity coincide with the publishing of interesting posts, our participation in different events (e.g. events, news, e-Bulletin).

The visitors of the website are located in the following countries:

	Country	Users	% Users
1.	Kenya	10	43.48%
2.	United States	4	17.39%
3.	Iran	3	13.04%
4.	Germany	2	8.70%
5.	Greece	2	8.70%
6.	Belgium	1	4.35%
7.	India	1	4.35%

Figure 3: PhasmaFOOD Website Analytics – Location

	Page	Pageviews	Unique Pageviews	Avg. Time on Page	Entrances	Bounce Rate	% Exit
		19,890 % of Total: 100.00% (19,890)	14,752 % of Total: 100.00% (14,752)	00:01:35 Avg for View: 00:01:35 (0.00%)	9,516 % of Total: 100.00% (9,516)	70.69% Avg for View: 70.69% (0.00%)	47.84% Avg for View: 47.84% (0.00%)
1.	/	6,346 (31.91%)	4,621 (31.32%)	00:01:43	4,318 (45.38%)	62.83%	53.66%
2.	/about-phasmafood	1,902 (9.56%)	1,594 (10.81%)	00:02:28	1,078 (11.33%)	85.42%	64.56%
3.	/partners	1,455 (7.32%)	1,194 (8.09%)	00:02:07	537 (5.64%)	79.48%	53.33%
4.	/documentation	746 (3.75%)	501 (3.40%)	00:02:01	113 (1.19%)	57.14%	33.51%
5.	/market	567 (2.85%)	432 (2.93%)	00:00:44	163 (1.71%)	73.17%	32.45%
6.	/contact	539 (2.71%)	410 (2.78%)	00:01:00	111 (1.17%)	61.82%	27.83%
7.	/news-0	471 (2.37%)	307 (2.08%)	00:01:22	120 (1.26%)	76.47%	27.18%
8.	/index.php	339 (1.70%)	325 (2.20%)	00:02:02	305 (3.21%)	91.45%	88.50%
9.	/node/140	319 (1.60%)	290 (1.97%)	00:02:55	249 (2.62%)	86.00%	78.06%
10.	/events	305 (1.53%)	213 (1.44%)	00:00:50	74 (0.78%)	70.27%	27.87%

Figure 4: PhasmaFOOD Website Analytics - Most visited pages

From the analytics, it springs that the Home page is the most visited one which is logical since this is the main page of the website. The About PhasmaFOOD page describing the project is the second most visited one (http://www.PhasmaFOOD.eu/about-PhasmaFOOD). In addition, the page describing the project consortium (the Partners page: http://www.PhasmaFOOD.eu/partners) is also one of the most popular pages meaning that the users visiting the website are interested to find information about the project team. The contact page, News, Market (how PhasmaFOOD is addressing the market) pages are also popular.

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

2.1.2 Social Media

Various social networks have been used as a marketing tool in order to promote in a regular basis activities and outputs of the project, while also encouraged a wider discussion on the topics related to PhasmaFOOD activities.

PhasmaFOOD had an active presence in the most popular social media, such as Twitter, Facebook, LinkedIn and YouTube, which are linked to the project's website.

Twitter

https://twitter.com/PhasmaFOOD
@PhasmaFOOD #PhasmaFOOD

Since the PhasmaFOOD account launch on February 2017, the project's Twitter activities have led to 200 followers (some of them being followed by thousands of followers) and 401 followed accounts. The total number of tweets is 315. Many of the project's tweets have been re-tweeted and reached by large audiences through the followers of the users that re-tweeted them.

Example of a Tweet with the relevant statistics:

Figure 5: Example of a Tweet and its statistics

Facebook

https://www.facebook.com/PhasmaFOOD-1892369860999522/

From February 2017, PhasmaFOOD maintains a Facebook fan page, in order to be reachable by a broader and probably less specialised audience. The project's Facebook page includes news, photos and information about the PhasmaFOOD project, its developments and activities. We also pursued to re-post relevant and interesting information from other accounts in order to enrich the page content and attract more fans.

The page has gained 101 followers.

Example of the posts with its main statistics (“likes”, shares, people reached):

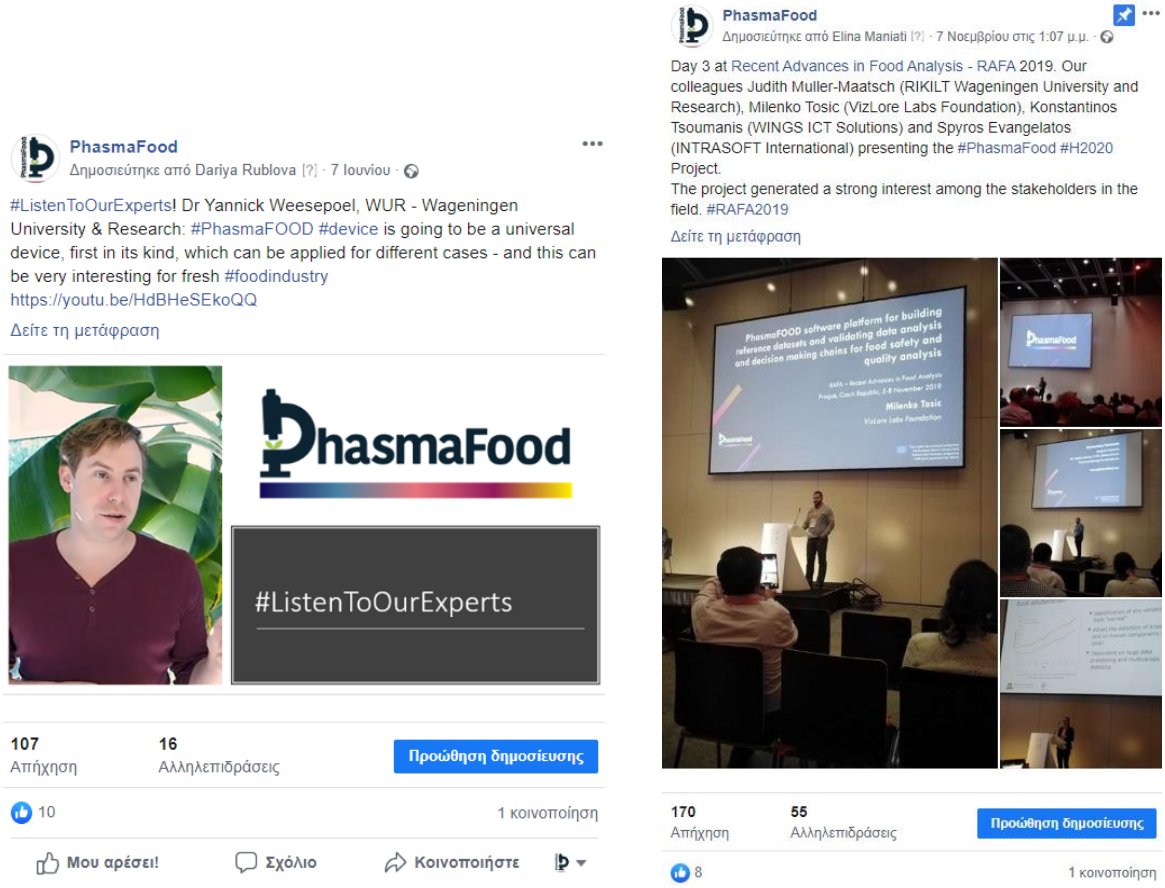


Figure 6: Example of Facebook posts

LinkedIn Group

https://www.linkedin.com/groups/13517281

PhasmaFOOD has created and maintains the PhasmaFOOD Project Community on Sensing Technologies for Food Quality & Safety Group to engage with various stakeholders.

PhasmaFOOD LinkedIn group of professionals counts 40 members and 52 posts including the project’s news and news from the industry.

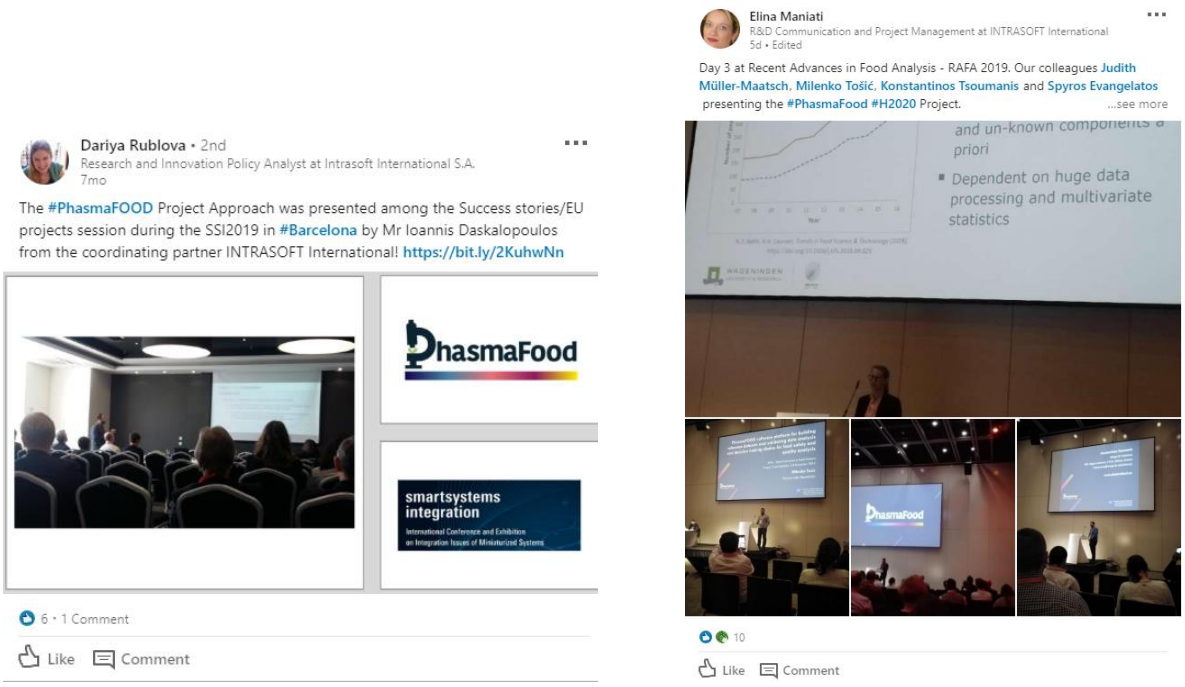
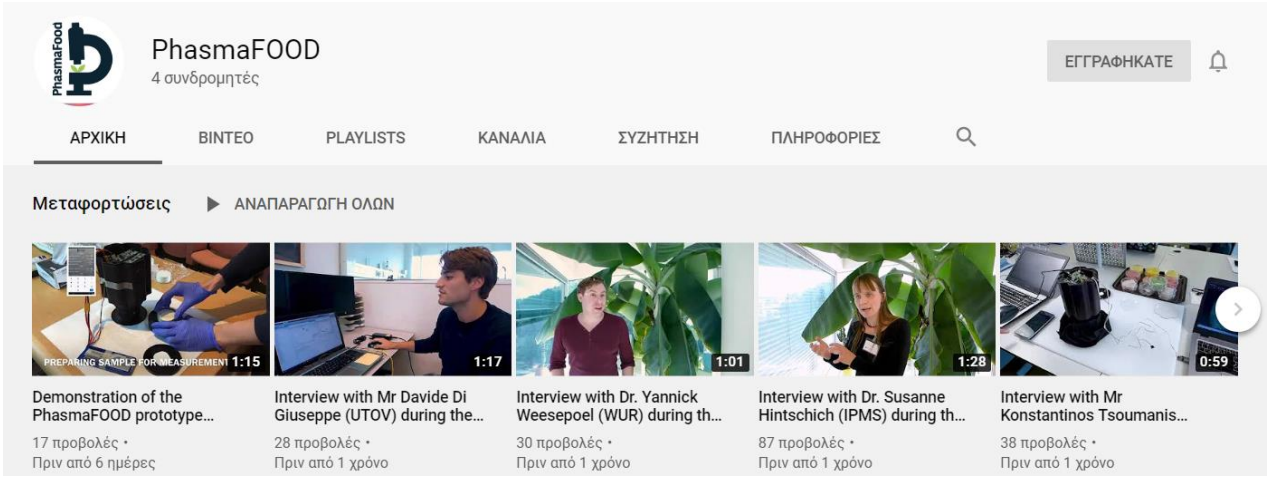


Figure 7: Example of LinkedIn posts

YouTube

PhasmaFOOD has created and maintains a channel in YouTube where visitors can find all the videos related to the project. Throughout the lifetime of the project 8 videos have been produced concerning 7 interviews with our experts and 1 video demonstrating the PhasmaFOOD prototype design.



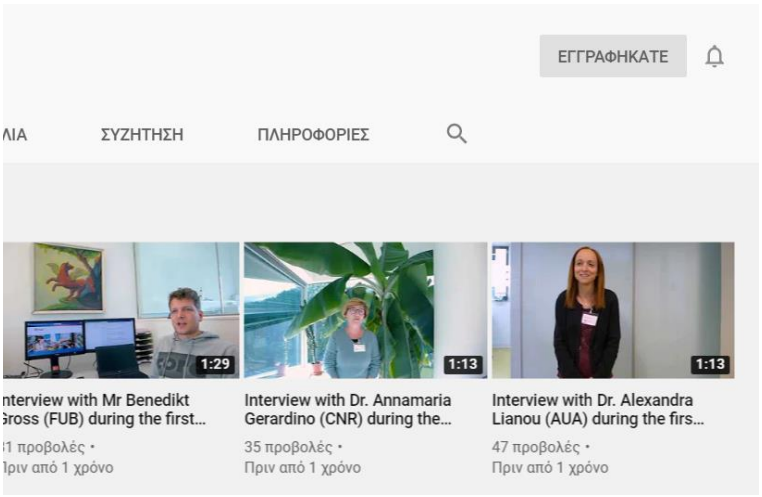


Figure 8: PhasmaFOOD YouTube Videos

2.1.3 e-Bulletin

e-Bulletin is the electronic newsletter of PhasmaFOOD to communicate news and information regarding its progress. INTRA has been responsible for structuring, collecting/writing content, placing into layout and issuing the e-Bulletins, while the project partners have been providing information and ensuring that the content is accurate.

E-Bulletins have been circulated on a periodical basis according to the project's milestones, achievements and activities. Throughout the life of the project six (6) newsletters were published (the last one including the project's outcomes will be published in January 2020).

Links to the project website and the social media channels have been provided both on the front page and the last page of the document (all are clickable leading directly to the requested page) in order to make it easier for the readers to look for more information on our website and follow our social media accounts.

All e-Bulletin issues have been uploaded on the project website and can be found by following this link: https://PhasmaFOOD.eu/index.php/library

Figure 9: PhasmaFOOD e-Bulletin examples

GDPR compliance

In order to comply with the new EU General Data Protection Regulation ("GDPR") consent requirements which came into effect on May 25, 2018, the following have taken place:

- We used Mailchimp GDPR alert forms adjusted to our needs and we sent an alert to the contacts in our mailing list asking for their confirmation and consent to receive content from us in a form of e-Bulletin.
- We created a GDPR compliant subscription button (using the MailChimp tool) on our website.
- We sent the e-Bulletins only to the contacts who were subscribed to our newsletters by following the GDPR-compliant way.

2.1.4 Images

Photos and informative images from PhasmaFOOD events and meetings have been used for the preparation of both our internal and external dissemination materials such as website articles, reports, presentations, etc. All images have been collected on the Photo Gallery folder on Redmine, the project's web-based repository.

2.1.5 Video(s)

Some of our multi-disciplinary experts talked about the PhasmaFOOD mission from the perspective of their field of expertise and explained their roles and ambitions concerning the project. The interviews took place during the first prototype testing @ our partner's RIKILT Wageningen University and Research premises in September 2018 and the videos can be found here:

https://PhasmaFOOD.eu/index.php/library (please go to the "Videos" section)

2.1.6 Infographics

A second project infographic aiming to present PhasmaFOOD concepts to both the professional stakeholders and a broader audience has been released.

The new infographic depicting the achievements of the project in terms of communication and dissemination activities has been uploaded on the project's website, has been displayed in the events we participated as a project and placed on the dissemination material section. It has been also included in our project presentations.

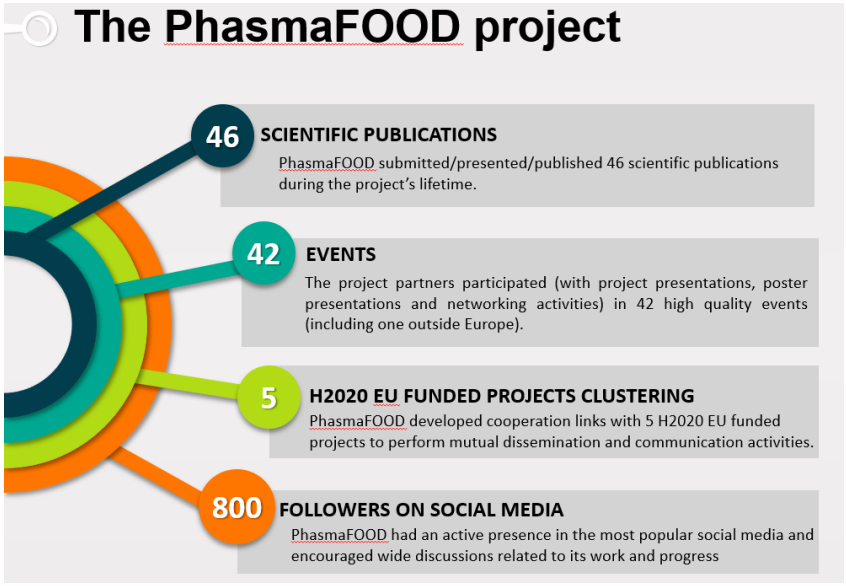


Figure 10: PhasmaFOOD Infographic

2.2 Events - Based Dissemination

PhasmaFOOD has been involved in a variety of event formats, ranging from quality, international conferences and workshops to fair trades and exhibitions.

2.2.1 Participation to events

During the last 18 months, the project partners represented PhasmaFOOD at several events aiming to promote and disseminate by all relevant means and tools, all relevant information that could increase the project visibility. Participation in events has been also an opportunity to increase and strengthen the network of relevant parties interested in becoming target audiences and multipliers of PhasmaFOOD.

PhasmaFOOD representation in these events took place in different ways, including paper or project presentation, poster presentation, simple participation for liaising or networking purposes. Project promotional material such as brochures, event-specific scientific posters but also the project's identification material (pens and bags) were also extensively used for dissemination purposes.

Table 1: Events participation (M19-M36)

Title	Place	Dates	Audiences
26th International ICFMH Conference - FoodMicro 2018	3-6/09/2018	Berlin, Germany	Industry, government, and academia
17th European Conference on Computational Biology and Bioinformatics (ECCB2018)	12/09/2018	Athens, Greece	Scientists working in a variety of disciplines, including bioinformatics, computational biology, biology, medicine, and systems biology
Meeting on food fraud detection technologies at the Danish Institute of Technology	12/09/2018	Aarhus, Denmark	Academia
12th Annual MNBS 2018 Workshop	16-18/10/2018	Thessaloniki, Greece	Academia

Rapid Methods Europe	5-7/11/2018	Amsterdam, the Netherlands	scientists, technologists, and professionals wishing to gain insight into to innovations and breakthroughs in rapid analysis & diagnostics
5th FoodIntegrity Conference on "Assuring the integrity of the food chain: Delivering real world solutions"	14-15/11/2018	Nantes, France	Academia
6th Meat Conference	1-3/02/2019	Thessaloniki, Greece	Academia
Primary Health Care educational workshop "G. Papadakis" round table entitled "Food safety: guaranteed or sought out?"	13/02/2019	Athens, Greece	Academia
2nd European Biosensor Symposium	18-21/02/2019	Florence, Italy	Young and experienced researchers in the field
Info day at Faculty Of Science (University of Novi Sad)	12/03/2019	Novi Sad, Serbia	Students and professors from department for computer science
4th International Conference on Optical Characterization of Materials (OCM-2019) (biannual German event organised by Fraunhofer IOSB)	13-14/03/2019	Fraunhofer IOSB in Karlsruhe, Germany	Academia
Smart Systems Integration (SSI) 2019	10-11/04/2019	Barcelona, Spain	Smart Systems Integration brings together experts in smart systems and their applications from all over Europe.

Workshop for student practice at Faculty of Technical Sciences	15/04/2019	Novi Sad, Serbia	Students and professors from department for information systems
International Association for Food Protection (IAFP) European Symposium	24-25/04/2019	Nantes, France	Industry, government and academia
5th Metabolomics Workshop, Aristotle University of Thessaloniki	16-17/05/2019	Thessaloniki, Greece	Scientific
International Association for Food Protection (IAFP) Annual Meeting	21-24/07/2019	Louisville, Kentucky, USA	Industry, government and academia
JENCOLOR SpectroNet Collaboration Conference 2019	28-29/08/2019	Jena, Germany	Photonics industry and academics
Food Scanner and Stakeholders	26/09/2019	Munich, Germany	Photonics industry, Government agencies, Academic scientists, Experts in miniaturized photonics used in food assessment
Recent Advances in Food Analysis - RAFA2019	5-9/11/2019	Prague, CZ	Relevant industry representatives, Food Safety & Quality professionals

Highlights from selected events

PhasmaFOOD showcased its results at the 9th International Symposium on Recent Advances in Food Analysis-RAFA 2019, in Prague

PhasmaFOOD showcased its results at the 9th International Symposium on Recent Advances in Food Analysis –RAFA 2019 which took place between 5-8 November 2019, in Prague. An international meeting bringing together food scientists from academia and industry, national and international agencies, control authorities and governmental and commercial laboratories.

In the Smart-Lab, RAFA participants were able to challenge the prototype by detecting food adulterations in skimmed milk powder. While participants often struggled to correctly identify milk powder using their eyes and nose, the PhasmaFOOD device was able to correctly identify 100% of the skimmed milk powders. Hence, the underlying chemometrics and established database were perfectly incorporated in the software. Lots of participants were astonished by the simplicity of the usage and the intelligent design of the device.

Smart Systems Integration (SSI) 2019

Smart Systems Integration brings together experts in smart systems and their applications from all over Europe. The international conference and exhibition will be taking place in Barcelona from 10 through 11 April 2019.

PhasmaFOOD will be presented with the paper titled “Food analysis for all: The PhasmaFOOD project approach” at the SSI 2019 conference.

PhasmaFOOD with two presentations at the OCM-2019

PhasmaFOOD was represented at the OCM-2019 with two papers:

- “PhasmaFOOD - A miniaturized multi-sensor solution for rapid, non-destructive food quality assessment” / B. Groß; ZEDAT-FU Berlin and
- "Exploiting multispectral imaging for non-invasive assessment of the microbiological quality and authenticity of food commodities" / G. Nychas; Agricultural University of Athens

The brochures of the project were shared among the interested participants.

The International Conference on Optical Characterization of Materials (OCM-2019) was organized by the Karlsruhe Center for Spectral Signatures of Materials (KCM) in cooperation with the German Chapter of the Instrumentation & Measurement Society of IEEE.

The PhasmaFOOD project approach presented at the SSI 2019

Smart Systems Integration brings together experts in smart systems and their applications from all over Europe. The international conference and exhibition took place in Barcelona from 10 through 11 April 2019.

Mr Ioannis Daskalopoulos from INTRASOFT International presented the paper titled “Food analysis for all: The PhasmaFOOD project approach” at the Success Stories/EU Projects session at the SSI 2019 conference.

Ioannis shared the latest developments and very promising findings of the project in the direction of food analysis using spectroscopy techniques.

While there is still room for improvement, the current software and hardware combination constitutes a very solid, cost effective and user-friendly approach towards safeguarding public health.

The 1st Prototype PhasmaFOOD multi-sensor successfully presented at the 5th Food Integrity Conference

The first integrated PhasmaFOOD multi-sensor prototype device was presented by our partner, Yannick Weesepoel (RIKILT Wageningen University and Research) at the 5th Food Integrity Conference. The project, the prototype and the technologies put in place generated significant interest among the stakeholders in the field and the industry.

Around 400 attendees from the food processing industry, food retailers, food safety agencies, public administration and research organisations attended the multi-disciplinary conference focusing on “Delivering real world solutions”. The conference organised by the FoodIntegrity project took place from 14 to 15 November 2018 in Nantes, France and offered keynote lectures and panels on the main innovative topics in food integrity. Solutions to be implemented in the food sector were presented. High-level keynote speakers debated current issues and provided insight on the future fight against food fraud.

PhasmaFOOD prototype device and open software architecture presented at the RME 2018

RME2018 is the 12th conference in the Rapid Methods Europe series dedicated to innovations and breakthroughs in rapid analysis & diagnostics across the agri-food, water, animal health and healthcare sectors. This 12th edition took place on 5-7 November 2018 in Amsterdam. RME2018 aimed to further strengthen the academia-industry relations and disseminate advanced research towards practical applications. More than 250 scientists, technologists, and professionals wishing to gain insight into to innovations and breakthroughs in rapid analysis & diagnostics, attended the event.

The PhasmaFOOD partner, Judith Muller-Maatsch (RIKILT Wageningen University and Research), presented the results of the successful food adulteration detection in skimmed milk 'one-class model' multivariate statistics. Further adulteration studies include alcoholic beverages, edible oils, and meat products.

Note that apart from adulteration, the PhasmaFOOD team is also testing the device in the detection of mycotoxins in grains and nuts using fluorescence testing and in the detection of early signs of food spoilage in fruits, vegetables, meat and fish using spectroscopy scans.

PhasmaFOOD latests results were extensively discussed in face-to-face meetings with the interested industry and academia representatives, as well as with the stakeholders from the other relevant scientific projects.

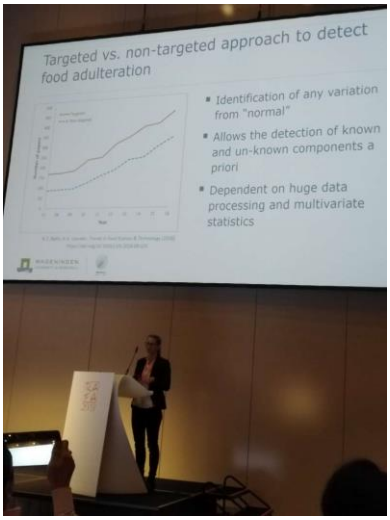
2.2.2 Events organization

Special session and Smart Lab session organisation

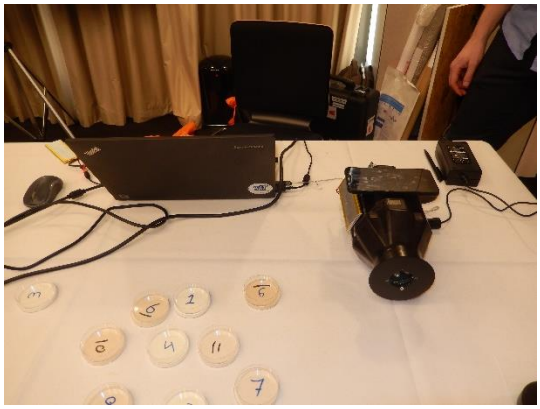

The 9th International Symposium on Recent Advances in Food Analysis (RAFA) is an international meeting bringing together food scientists from academia and industry, national and international agencies, control authorities and governmental and commercial laboratories. Having taken place in Prague on November 5-8, 2019, RAFA provided opportunities for participants to network with hundreds of food scientists and practitioners from all over the globe that convened for this exciting event.


During the RAFA symposium, Spyros Evangelatos, from the project coordinator INTRASOFT International, introduced PhasmaFOOD project to the audience. His presentation was focused on the project's main goals and objectives targeting the on-the-spot food quality sensing. Apart from the implementation roadmap from the early stages of the project, a brief description of each use-case that has been tested within PhasmaFOOD's lifespan was given highlighting the promising results and comparing them with the use of only one spectroscopy technology.

Konstantinos Tsoumanis, from Wings ICT Solutions, presented the hardware part of the PhasmaFOOD project placing special focus on the sensing node and the supporting electronics parts of the sensing device. The sensing and lighting components of the sensing node were presented, as well as the electronic board, which controls the operation of the sensing device and was designed and developed from the start tailored to the needs of the project. The technical challenges of developing the embedded software at low and high level were also presented. Along with Yannick Weesepoel from Wageningen Food Safety Research, they also pointed out the challenge of making various engineering domains to collaborate in order to deliver the final system, as well as the challenging yet interesting part of discussions between ICT partners and food laboratories throughout the project since two generally different "worlds" had to communicate each other.



Our partner Milenko Tosic from Vizlore Labs Foundation presented the software side of the PhasmaFOOD system from embedded over mobile application to the cloud platform. Milenko together with the other members of our team discussed also the PhasmaFOOD solution with RAFA participants who showed interest in the project and our demo.



Our partner Judith Müller-Maatsch, presented the results of her team from Wageningen Food Safety Research that worked on the detection of food adulteration using the PhasmaFOOD device and outlined their approach of a non-targeted food adulteration detection and gave details on the applied chemometrics.

The demo session attracted a significant number of visitors, who were interested in seeing the PhasmaFOOD system scanning milk powders, analyzing sensory data and making real-time decisions on whether the sample was adulterated or not. We discussed with visitors from the food industry and companies/research institutes interested in spectroscopy-based food analysis, accepting their active interest and encouraging comments on the PhasmaFOOD solution. Potential stakeholders expressed their interest in the exploitation of the PhasmaFOOD system and were eager to know when the commercial system would be ready.

Our partner Francesca Romana Bertani from Consiglio Nazionale delle Ricerche presented two posters, showing the results on aflatoxin contamination use case and technical challenges for integration of photonic sensors and illumination sources.

Spyros Evangelatos from INTRASOFT International presented a poster regarding the use of the spectroscopy-based PhasmaFOOD sensors for the detection of minced meat adulteration.

Over 750 representatives attended the symposium from about 50 countries, leading to a wide variety of expertise in the field of food analysis, regulation and hardware development.

2.3 Publications

2.3.1 Scientific papers and publications

Scientific publication acknowledgement is included in each submitted paper: “This work has been supported by the project PhasmaFOOD, funded from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 732541”

PhasmaFOOD acknowledges the importance of Open Access (OA) policies towards accelerating and broadening the dissemination of the publicly-funded results of the project, as well as towards boosting the visibility of European research. PhasmaFOOD researchers and partners has be given the freedom to choose any of the following two open-access publishing modalities: 1) Gold OA in open-access journals (either full or hybrid). As part of this option, the partners were responsible for handling the publication fees; 2) Green OA through self-archiving journal articles or through OA repositories. Researchers have been offered the option to publish in journals registered in the Registry of Open Access Repositories.

PhasmaFOOD submitted/presented/published several scientific publications during the project’s lifetime which are listed in the table below.

Table 2: Publications (M1-M36)

Type of publication *	Title *	Authors/affiliation *	Status * (SUBMITTED / ACCEPTED)	Title of the Journal/Proceedings/Books series/Book (for book chapters)	Publisher *	Place of publication *	Year of publication *
Publication in Conference book of abstract	A photonic smart system for food quality and safety sensing: first integration and measurement results	F.R. Bertani, P. Bourgos, L. Businaro, L. Gambacorta, A. Gerardino , S. Hintschich, G. Koutalieris, M. Logothetis, E. Martinelli , G.J. Nychas, .M.Solfrizzo, M. Tosic, G. Wunder	PRESENTED	23rd International Conference on Micro and Nano Engineering	MNE2017	Braga, Portugal	2017
Publication in Conference proceedings/workshop		P. Bourgos, A. Gerandino and S. Hintschich and M. Tosic, G. Nychas, G. Koutalieris, Y. Weesepoel, G. Wunder, E. Martinelli, M. Logothetis, P. Vlacheas, P. Demestichas	PRESENTED	Studies in Computational Intelligence	Springer	Belgrade, Serbia	2017
Publication in Conference proceedings/workshop	NIR spectroscopy in food sensing – a combined sensing approach	Susanne Hintschich, Hans-Georg Dallmann, Heinrich Grüger, Jens Knobbe, Michael Leuckefeld, Tino Pügner, Peter Reinig, F. R. Bertani, P. Bourgos, L. Businaro, A. Gerardino, G. Koutalieris, E. Martinelli, G.J. Nychas, M. Tosic, Y.Weesepoel, G. Wunder	PRESENTED	8th International Symposium on Recent Advances in Food Analysis (RAFA 2017, Book of Abstracts)	RAFA 2017R	Prague, Czech Republic	2017
Publication in Conference proceedings/workshop	Miniature Photonic System For Next Generation Food Quality Authentication	S. Hintschich and P. Reinig		Proceedings of ICNIRS2017			2017
Publication in Conference proceedings/workshop	PhasmaFOOD; Portable photonic miniaturised smart	G.-J.E. Nychas, G. Koutalieris, P. Bourgos	PRESENTED	10th International Conference on	ICPMF 2017	Cordoba, Spain	2017

	system for on-the-spot food quality sensing			Predictive Modelling in Food			
Publication in Conference proceedings/workshop	Microbiological quality assessment of aquacultured fish using Fourier transform infrared spectroscopy	L. Fengou, A. Lianou, E. Gkana, E.Z. Panagou, G.-J.E. Nychas	PRESENTED	31st EFFoST International Conference "Food Science and Technology Challenges for the 21st Century- Research to Progress Society"	31st EFFoST International Conference "Food Science and Technology Challenges for the 21st Century- Research to Progress Society"	Sitges, Spain	2017
Publication in Conference proceedings/workshop	The key role of Process Analytical Technology (PAT), Information Technology (IT) and predictive modelling in enhancing food safety	F. Mohareb, E.Z. Panagou, G.-J.E. Nychas	PRESENTED	10th International Conference on Predictive Modelling in Food	ICPMF 2017	Cordoba, Spain	2017
Publication in Conference proceedings/workshop	Detection of food spoilage using spectroscopy- and multispectral imaging-based sensors	L. Fengou, A. Lianou, P. Tsakanikas, E.Z. Panagou, G.-J.E. Nychas	PRESENTED	8th International Symposium on Recent Advances in Food Analyses (RAFA)	RAFA 2017	Prague, Czech Republic	2017
Publication in Conference proceedings/workshop	PhasmaFOOD: A Food Sensing Device and an	G. Koutalieris, Y. Weesepoel		8th International Symposium on Recent Advances		Prague, Czech Republic	2017

	Open Software Architecture delivering Food-Tech Innovation			in Food Analyses (RAFA)			
Publication in Conference proceedings/workshop	The role of information technologies (IT) and process analytical technology (PAT) in the determination of fraud, quality and safety of foods	G.-J.E. Nychas, E.Z. Panagou	PRESENTED	1st Athens Innovation Festival	1st Athens Innovation Festival	Athens, Greece	2017
Publication in Conference proceedings/workshop	Estimation of the microbiological quality of minced pork using Fourier transform infrared spectroscopy and multispectral imaging	L. Fengou, E. Spyrelli, A. Lianou, P. Tsakanikas, G.-J. E. Nychas	PRESENTED	2018 IAFP's European Symposium	IAFP 2018	Stockholm, Sweden	2018
Publication in Conference proceedings/workshop	Microbiological spoilage of cut ready-to-eat pineapple during storage under different temperature conditions	E. Manthou, V. Dagres, A. Lianou, G.-J.E. Nychas	PRESENTED	2018 IAFP's European Symposium	IAFP 2018	Stockholm, Sweden	2018
Publication in Conference proceedings/Workshop	Exploitation of Information Technology for state-of-the-art food quality assessment systems	P. Tsakanikas	PRESENTED	Athens Science Festival	Athens Science Festival	Athens, Greece	2018
Publication in Conference proceedings/Workshop	Innovation in Greek Agriculture	G. Nychas	PRESENTED	3rd Agricultural Conference of Naftemporiki	Naftemporiki	Athens, Greece	2018

Other	PhasmaFOOD – a combined sensing approach for food safety	S. Hintschich, R. Zschiedrich			Sächsisches Staatsministerium für Wissenschaft und Kunst	Dresden, Germany	2017-2018
Publication in Conference proceedings/workshop	Infrared spectroscopy and multispectral imaging as means of assessing the microbiological spoilage of minced pork stored under modified atmosphere packaging	L.-C. Fengou, E. Spyrelli, A. Lianou, E.Z. Panagou, G.-J.E. Nychas	PRESENTED	26th International ICFMH Conference - FoodMicro 2018	FOODMICRO 2018	Berlin, Germany	2018
Publication in Conference proceedings/workshop	Modelling the growth kinetics of *Pseudomonas* spp. on *Pleurotus ostreatus* mushrooms under non-isothermal conditions	F. Tarlak, E. Manthou, V. Dagres, A. Lianou, M. Ozdemir, G.-J. E. Nychas	PRESENTED	26th International ICFMH Conference - FoodMicro 2018	FOODMICRO 2018	Berlin, Germany	2018
Publication in Conference proceedings/workshop	Spectroscopy-based sensors under a unified feature selection approach for microbial contamination and storage time prediction of ready-to-eat rocket	P. Tsakanikas, E. Manthou, L.-C. Fengou, A. Lianou, E.Z. Panagou, G.-J. E. Nychas	PRESENTED	26th International ICFMH Conference - FoodMicro 2018	FOODMICRO 2018	Berlin, Germany	2018

Publication in Conference proceedings/workshop	An Information Technology based platform for food safety and quality management systems	G. Nychas, Mohareb, F., Panagou, E.	PRESENTED	26th International ICFMH Conference - FoodMicro 2018	FOODMICRO 2018	Berlin, Germany	2018
Publication in Conference proceedings/workshop	Implementation of communication technologies in tandem with bioinformatics for the assessment of food quality and safety	G. Nychas, Sims, E.Z. Panagou, F. Mohareb	PRESENTED	17th European Conference on Computational Biology and Bioinformatics	ECCB2018	Athens, Greece	2018
Scientific Journal	MycoKey Round Table Discussions of Future Directions in Research on Chemical Detection Methods, Genetics and Biodiversity of Mycotoxins	Leslie, J.F.; Lattanzio, V.; Audenaert, K.; Battilani, P.; Cary, J.; Chulze, S.N.; De Saeger, S.; Gerardino, A.; Karlovsky, P.; Liao, Y.-C.; Maragos, C.M.; Meca, G.; Medina, A.; Moretti, A.; Munkvold, G.; Mulè, G.; Njobeh, P.; Pecorelli, I.; Perrone, G.; Pietri, A.; Palazzini, J.M.; Proctor, R.H.; Rahayu, E.S.; Ramírez, M.L.; Samson, R.; Stroka, J.; Sulyok, M.; Sumarah, M.; Waalwijk, C.; Zhang, Q.; Zhang, H.; Logrieco, A.F.	ACCEPTED	Special Issue "1st International MYCOKEY Conference: Advances on Mycotoxin Reduction in the Food and Feed Chain"	MDPI		2018
Publication in peer-reviewed scientific journal	Evaluation of Fourier transform infrared spectroscopy and multispectral imaging as means of estimating the microbiological spoilage of farmed sea bream	Lemonia-Christina Fengou, Alexandra Lianou, Panagiotis Tsakanikas, Eleni N. Gkana, Efstathios Z. Panagou, George-John E. Nychas	PUBLISHED	Food Microbiology	Elsevier	Amsterdam, The Netherlands	2019

Publication in peer-reviewed scientific journal	A unified spectra analysis workflow for the assessment of microbial contamination ready-to-eat green salads: Comparative study and application of non-invasive sensors	Panagiotis Tsakanikas, Lemonia-Christina Fengou, Evanthia Manthou, Alexandra Lianou, Efstathios Z. Panagou, George-John E. Nychas	PUBLISHED	Computers and Electronics in Agriculture	Elsevier	Amsterdam, The Netherlands	2018
Publication in peer-reviewed scientific journal	Prediction of indigenous *Pseudomonas* spp. growth on oyster mushrooms (*Pleurotus ostreatus)* as a function of storage temperature	Evanthia Manthou, Fatih Tarlak, Alexandra Lianou, Murat Ozdemir, Georgios I. Zervakis, Efstathios Z. Panagou, George-John E. Nychas	PUBLISHED	LWT-Food Science and Technology	Elsevier	Amsterdam, The Netherlands	2019
Publication in Conference proceedings/workshop	PhasmaFOOD: Next-generation Multisensor Food Scanner and an Open Software Architecture delivering Food-tech innovation	Paraskevas BOURGOS, Georgios KOUTALIERIS	ACCEPTED	12th Annual MNBS 2018 Workshop			
Publication in Conference proceedings/workshop	Multispectral Imaging as «Tool» for the Rapid Detection of Raw Meat Adulteration	Lemonia-Christina Fengou, Danai Roumani, Alexandra Lianou, Efsthathios Z. Panagou, George-John E. Nychas	PRESENTED	6th Meat Conference	6th Meat Conference	Thessaloniki, Greece	2019
Publication in Conference proceedings/workshop	Evaluation of the Microbiological Quality of Minced Pork using Fourier Transform Infrared	Lemonia-Christina Fengou, Evgenia Spyrelli, Alexandra Lianou, Efstathios Z. Panagou, George-John E. Nychas	PRESENTED	6th Meat Conference	6th Meat Conference	Thessaloniki, Greece	2019

	Spectroscopy and Multispectral Imaging						
Publication in Conference proceedings/workshop	Process Analytical Technology in the Food Industry: Potential Applications in the Manufacture of Meat and Meat Products	Alexandra Lianou and George-John E. Nychas	PRESENTED	6th Meat Conference	6th Meat Conference	Thessaloniki, Greece	2019
Publication in Conference proceedings/workshop	Adoption and Exploitation of New and Information Technologies into the Scheme of Process Analytical Technology in the Meat Industry	Panagiotis Tsakanikas, Alexandra Lianou, Efstathios Z. Panagou and George-John E. Nychas	PRESENTED	6th Meat Conference	6th Meat Conference	Thessaloniki, Greece	2019
Publication in Conference proceedings/workshop	Detection of Minced Beef Adulteration by Means of Multispectral Vision Technology	Lemonia-Christina Fengou, Alexandra Lianou, Panagiotis Tsakanikas, Efstathios Z. Panagou, George-John E. Nychas	PRESENTED	2019 IAFP's European Symposium	IAFP 2019	Nantes, France	2019
Publication in Conference proceedings/workshop	Rapid Assessment of Fish Microbiological Quality with Spectroscopy-based Sensors	Lemonia-Christina Fengou, Alexandra Lianou, Panagiotis Tsakanikas, Efstathios Z. Panagou, George-John E. Nychas	PRESENTED	2019 IAFP's European Symposium	IAFP 2019	Nantes, France	2019
Publication in Conference proceedings/workshop	Estimation of Microbial Spoilage of Ready-to-eat Baby Spinach using Fourier Transform Infrared Spectroscopy	Evanthia Manthou, Anastasia Bakalaki, Alexandra Lianou, Panagiotis Tsakanikas, Efstathios Z. Panagou and George-John E. Nychas	PRESENTED	2019 IAFP's European Symposium	IAFP 2019	Nantes, France	2019

Publication in Conference proceedings/workshop	Microbial spoilage of gilthead seabream during storage under modified atmospheres at different temperatures	Sophia Vorri, Lemonia-Christina Fengou, Alexandra Lianou, George-John E. Nychas	PRESENTED	8th MBK Conference	Hellenic Initiative Mikrobiokosmos (MBK)	Patras, Greece	2019
Publication in Conference proceedings/workshop	Exploiting multispectral imaging for non-invasive assessment of the microbiological quality and authenticity of food commodities	Lemonia-Christina Fengou, Panagiotis Tsakanikas, Efstathios Z. Panagou, George-John E. Nychas	PRESENTED	4th Conference on Optical Characterization of Materials (OCM 2019)	OCM 2019	Karlsruhe, Germany	2019
Publication in Conference proceedings/workshop	Evaluation of the microbiological spoilage of ready-to-eat pineapple through infrared spectroscopy and multispectral imaging (Original title in Greek: ΕΚΤΙΜΗΣΗ ΤΗΣ ΜΙΚΡΟΒΙΟΛΟΓΙΚΗΣ ΑΛΛΟΙΩΣΗΣ ΕΤΟΙΜΟΥ ΠΡΟΣ ΚΑΤΑΝΑΛΩΣΗ ΑΝΑΝΑ ΜΕΣΩ ΤΗΣ ΦΑΣΜΑΤΟΣΚΟΠΙΑΣ ΥΠΕΡΥΘΡΟΥ ΚΑΙ ΤΗΣ ΠΟΛΥΦΑΣΜΑΤΙΚΗΣ ΑΠΕΙΚΟΝΙΣΗΣ)	Evanthia Manthou, Evangelos Dagres, Alexandra Lianou, Panagiotis Tsakanikas, Efstathios Z. Panagou, George-John E. Nychas	PRESENTED	12th Panhellenic Scientific Conference of Chemical Engineering (12ο ΠΑΝΕΛΛΗΝΙΟ ΕΠΙΣΤΗΜΟΝΙΚΟ ΣΥΝΕΔΡΙΟ ΧΗΜΙΚΗΣ ΜΗΧΑΝΙΚΗΣ)	12th Panhellenic Scientific Conference of Chemical Engineering	Athens, Greece	2019
Publication in Conference proceedings/workshop	Multispectral Imaging as Rapid	Lemonia-Christina Fengou, Alexandra Lianou, Panagiotis	PRESENTED	2019 IAFP Annual Meeting	IAFP 2019	Louisville, Kentucky, USA	2019

	Method to Detect Adulteration of Fresh/ Frozen-Thawed Minced Chicken and Pork	Tsakanikas, Efstathios Z. Panagou, George-John E. Nychas					
Publication in Conference proceedings/workshop	Evaluation of the Microbiological Quality of Minced Pork using Visible and Fluorescence Spectroscopy Methods in Tandem with Multivariate Analysis	Lemonia-Christina Fengou, Alexandra Lianou, Panagiotis Tsakanikas, Efstathios Z. Panagou, George-John E. Nychas	PRESENTED	2019 IAFP Annual Meeting	IAFP 2019	Louisville, Kentucky, USA	2019
Publication in Conference proceedings/workshop	Application of Fluorescence Spectroscopy as a Tool for Microbial Spoilage Assessment in Fresh-cut Pineapple	Evanthia Manthou, Evangelos Dagres, Alexandra Lianou, Panagiotis Tsakanikas, Efstathios Z. Panagou, George-John E. Nychas	PRESENTED	2019 IAFP Annual Meeting	IAFP 2019	Louisville, Kentucky, USA	2019
Publication in peer-reviewed scientific journal	Estimation of minced pork microbiological spoilage through Fourier transform infrared and visible spectroscopy and multispectral vision technology	Lemonia-Christina Fengou, Evgenia Spyrelli, Alexandra Lianou, Panagiotis Tsakanikas, Efstathios Z. Panagou, George-John E. Nychas	PUBLISHED	*foods*	MDPI	Basel, Switzerland	2019
Publication in peer-reviewed scientific journal	Self-repairing Classification Algorithms for Chemical Sensor Array	Gabriele Magna1, Corrado Di Natale2 and Eugenio Martinelli1	ACCEPTED	Sensors And Actuators B			
Publication in Conference proceedings/workshop	"Food analysis for all: The	Stylianos Georgoulas, Paraskevas Bourgos, Milenko	PRESENTED	Smart Systems Integration (SSI) 2019		Barcelona, Spain	2019

	PhasmaFOOD project approach"	Tosic, Susanne Hintschich, Francesca Romana Bertani, Panos Tsakanikas, Benedikt Gross, Martin Alewijn, Eugenio Martinelli					
Publication in Conference proceedings/workshop	PhasmaFOOD software platform for building reference datasets and validating data analysis and decision-making chains for food safety and quality analysis	Milenko Tosic, Ognjen Ikovic, Paraskevas Bourgos, Giorgos Makantasis, Ioannis Daskalopoulos, George Tsoumanis, Benedikt Gross, Eugenio Martinelli, Panagiotis Vlacheas, Panagiotis Demestichas, Annamaria Gerardino, Pason Tsakanikas, Judith Muller - Maatsch	PRESENTED	9th International Symposium on Recent Advances in Food Analyses (RAFA)	RAFA 2019	Prague, Czech Republic	2019
Publication in Conference proceedings/workshop	Detection of adulteration in solid and liquid samples using a portable, non-invasive spectroscopic device	Judith Müller-Maatsch, Yannick Weesepoel, Michiel Wijtten, Martin Alewijn	PRESENTED	9th International Symposium on Recent Advances in Food Analyses (RAFA)	RAFA 2019	Prague, Czech Republic	2019
Publication in Conference proceedings/workshop	Use of the spectroscopy-based PhasmaFOOD sensors for the detection of minced meat adulteration	Lemonia-Christina Fengou, Alexandra Lianou, Panagiotis Tsakanikas, Efstathios Z. Panagou, Spyros Evangelatos, George-John E. Nychas	PRESENTED	9th International Symposium on Recent Advances in Food Analyses (RAFA)	RAFA 2019	Prague, Czech Republic	2019
Publication in peer-reviewed scientific journal	Online feature selection for robust classification of the microbiological quality of traditional vanilla cream by means of multispectral imaging	Alexandra Lianou, Arianna Mencattini, Alexandro Catini, Corrado Di Natale, George-John E. Nychas, Eugenio Martinelli, Efstathios Z. Panagou	PUBLISHED	*sensors*	MDPI	Basel, Switzerland	2019

Publication submitted in peer-reviewed scientific journal	Spectroscopic Analysis; a machine learning workflow for raw food classification in a future industry.	Panagiotis Tsakanikas, Apostolos Karnavas, Efstathios Panagou, George-John Nychas		Scientific Reports	Springer Nature Research		
Publication in peer-reviewed scientific journal	Optical detection of Aflatoxins B in grained almonds using fluorescence spectroscopy and machine learning algorithms	F. R. Bertani*, L. Businaro*, L. Gambacorta*, A.Mencattini# , D. Brenda#, D. Di Giuseppe#, A. De Ninno*, M. Solfrizzo*, E. Martinell#i, A. Gerardino* *=CNR (IFN/ISPA) #=UTOV	ACCEPTED	Food Control	Elsevier	TBC	TBC

2.3.2 Press Releases

During the second half of the project:

The PhasmaFOOD consortium announced that its first integrated prototype is fully assembled, functional and ready to be used in the 1st phase of validation and calibration activities of the project.

An announcement on our participation at RAFA 2019 has been created and disseminated via the Project's Social media accounts and the website and direct messages have been sent to the partners' networks before the event in order to create awareness among the potentially interested public.

A press release about PhasmaFOOD's successful participation and session co-organisation in the major event on food analysis, regulation and hardware development, RAFA 2019 in Prague, has been released by the consortium.

The PhasmaFOOD consortium prepared a Press Release about its workshop on "The role of Information Technology and Process Analytical Technology in assessing Food Quality & Safety The case of the PhasmaFOOD project" hosted by the Agricultural University of Athens in November 29th, 2019.

An announcement regarding the project's final prototype results will be released in January 2019.

All Press releases are illustrated on Annex I of the present project deliverable.

2.3.3 Press clippings & mentions on the third platforms

PhasmaFOOD has been specifically mentioned in several European and national paper media and reference to the relevant work has been made by the project partners in several broadcasts.

Example : Article for The PhasmaFOOD Project at FOOD-Lab online Magazine (www.food-lab.de)

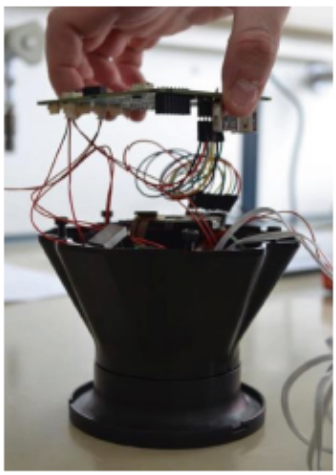
RUBRIK

Recent Advances in Food Analysis (RAFA) Restrospective

The PhasmaFOOD Project

›Author:
Evangelatos Spyros, T: +30 2106679183, M: Spyros.EVANGELATOS@intrasoft-intl.com,
W: intrasoft-intl.com

PhasmaFOOD[1] is an EU collaborative R&D project funded by the Horizon 2020 Programme with a strong consortium of 9 stakeholders with expertise in food safety, spectroscopy, hardware and software development and machine learning, namely Intrasoft International S.A, Wings ICT Solutions P.C., VizLore Labs Foundation, RIKILT – Wageningen Research, Agricultural University of Athens, Italian National Research Council, University of Tor Vergata, Fraunhofer IPMS and Freie Universität Berlin It aims at delivering a miniaturized multi-sensor optical sensing device for the detection of food safety threats such as food spoilage, adulteration and aflatoxins. PhasmaFOOD's vision is to improve existing food inspection methods that are time-consuming, non-portable and provide retrospective information and thus they cannot be used on-line or for scientific laboratory analysis and daily consumer usage.



The system integrates heterogeneous visible and near infrared spectroscopy technologies and is supported by a custom electronics design featuring embedded memory and processing power and a software architecture that delivers fast characterisation of foods, encompassing an extendable framework for the deployment of smart chemometric algorithms, data fusion strategies and reference laboratory measurements. The built-in algorithms address data mining and data analysis methods from non-destructive, non-invasive instruments and are independent of the food type and food-tech application.

20

RUBRIK

Figure 1: Real-time demonstration of the PhasmaFOOD system in RAFA symposium.

The architecture of the PhasmaFOOD system comprises three main parts: the sensing device, the end user's mobile device with the PhasmaFOOD application installed on it, and the cloud platform and database. The PhasmaFOOD sensing device integrates a sensing node, which includes an Ultraviolet-Visible (UV-VIS) spectrometer , a Near-Infrared (NIR) spectrometer, a camera, and Ultraviolet (UV), white and NIR illumination sources, in order to conduct the sensory measurements on the food samples and an electronic subsystem, which supports the operation of the sensing node by controlling the sensing measurements, collecting the sensory data, partially processing them and sending them to the end user's mobile device. The mobile device communicates the sensory data and contextual information to the cloud platform for further analysis. The cloud platform returns to the end user (at their mobile application/ screen) the final decision on their scanned food sample.

The PhasmaFOOD solution is designed to meet three major requirements:

- **Portability:** the spectrometer is hand-held and can be configures on the mobile app. Hence it works in various environments where food is sold or processed.
- **Versatility:** The specific combination of sensors (NIR, UV-VIS and CMOS camera) covers a spectral range from 400 nm to 1900 nm. This way, a plethora of food types and use cases can be targeted.
- **Fast, not-destructive predictions:** The three optical sensors are functioning without the need to damage the product under investigation and deliver a measurement instantly. Therefore, it is well suited to time-critical problems such as the shelf-life prediction of raw meat or fish, where waiting several days for the laboratory measurements is not an option.

The second integrated PhasmaFOOD prototype device was successfully assembled in the beginning of August 2019 and is now functional and ready to be used in the second phase of validation and calibration activities of the project. PhasmaFOOD food quality partners can use the PhasmaFOOD prototype in order to collect information and experimental data allowing the continuation of data analysis and the completion of experiments for three diverse use cases.

The first case on mycotoxins will focus on the presence of aflatoxins and (when applicable) deoxynivalenol in maize flour, skimmed milk powder, paprika powder and tree nuts. The next case focuses on spoilage and shelf-life estimation of fruits, vegetables meat and fish. The last use case on food fraud will cover skimmed milk powder, meat, olive oils and other edible oils and alcoholic beverages. The limits of detection for the use cases are generally based on either EU legislation or technical feasibility as described in peer reviewed scientific papers. Some of these use case scenarios were successfully demonstrated via the PhasmaFOOD system in the 9th International Symposium on Recent Advances in Food Analysis[2] with extremely promising results. Many of the event participants were able to see first hand the whole process followed by experts in order to detect fraudulent skimmed milk powder and registered as early adopters of the proposed PhasmFOOD solution.

PhasmaFOOD is addressing a market where similar devices are already positioned, and customers and the general public are increasingly becoming familiar with food sensing technologies. Strong R&D and product-driven development are important strengths of PhasmaFOOD and the consortium is capitalising upon them seeking synergies with similar development efforts. In addition, rapid exploitation opportunities are pursued via pilot applications addressing niche food markets.

References:

[1] www.phasmafood.eu
[2] www.rafa2019.eu

21

Figure 11: The PhasmaFOOD Project at FOOD-Lab online Magazine

Significant project achievements and research results, which became available during the second half of the project, were published on the professional specialised platforms Cordis (https://cordis.europa.eu/article/rcn/124667/en).

2.4 Paper Based Dissemination

2.4.1 Dissemination Material

Project Brochure

PhasmaFOOD's brochure has been featured and described in the deliverable D7.3 "Dissemination Plan".

The brochure has been distributed by the project partners for dissemination/communication and awareness raising purposes to target stakeholders during the events, conferences, workshops and other appropriate fora.

Project Posters

The general poster of the Project has been used to raise the awareness of the stakeholders and a variety of audiences with succinct textual and graphical information. The poster has been used during conferences, workshops, trade fairs/exhibitions and other relevant events.

In addition to the general project poster, other specific scientific posters have been prepared by the partners for their participation in scientific conferences.

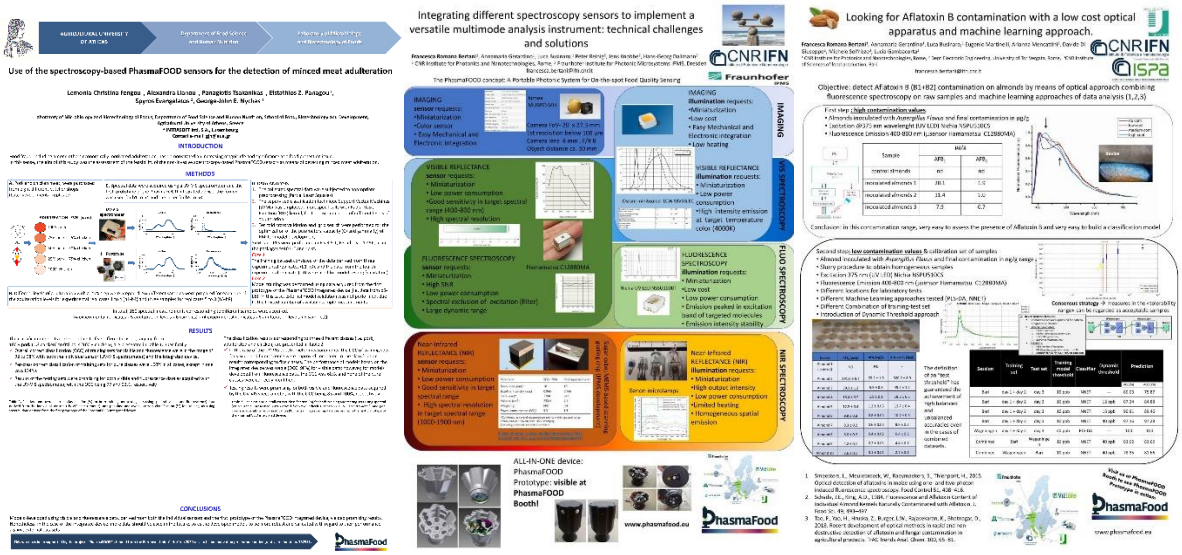


Figure 12: Examples of the PhasmaFOOD scientific posters presented at RAFA 2019 in Prague

2.5 Collaboration with other projects and initiatives

2.5.1 New clustering activities with other EU projects

FoodSmartPhone

PhasmaFOOD and the EU FoodSmartPhone projects (http://www.foodsmartphone.eu/) took the lead in organising a "Smart portable and personalized food analysis systems" as well as a dedicated "smart lab" during the RAFA 2019 that took place in Prague, 5-8 November 2019. More information on PhasmaFOOD sound participation at RAFA2019 can be found in the section 1.2 of the present document.

PhasmaFOOD has additionally developed cooperation links with the following projects mainly focusing on mutual dissemination and communication activities.

PROTEIN Project

PROTEIN is a research initiative led by a consortium of European public- and private-sector organizations working to promote health and wellbeing. By bringing together experts from across Europe, PROTEIN will develop tools using the latest communications technologies and machine learning strategies to provide personalized nutrition and physical activity support to EU citizens. PROTEIN has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement No 817732.

NUTRISHIELD Project

The core concept of NUTRISHIELD is to protect the health of EU citizens, by promoting a fact-based personalised nutrition. More specifically, NUTRISHIELD focuses on providing a holistic approach towards the personalisation of nutrition for the younger population, ranging from new-born infants all the way to young adults. Public health campaigns, most of them with a one-size-fits-all approach, have hardly been effective in mitigating the nutrition-related noncommunicable diseases and its consequences. Recent academic studies in the field of human nutrition show that differences between individuals determine how their health is affected by their diet. This implies that different individuals could respond differently to the same their diets. Therefore, in order for this to succeed, there needs to be a personalization of diet, based on scientific facts.

The project Zerstörungsfreie Messmethode zur schnellen Qualitätsbewertung und Haltbarkeitsabschätzung von Lebensmitteln mithilfe von Food-Scannern which aims to develop a fast and non-destructive measurement method for quality assessment and shelf life assessment of selected foods.
http://www.kern.bayern.de/wissenschaft/163847/index.php

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

2.6 Other dissemination and communication activities

In addition to the activities mentioned above, WSFR created awareness within the company and shared it with governmental agencies. PhasmaFOOD results were presented at so-called PosterLunches.

2.7 Monitoring and Evaluation of Dissemination and Communication Activities

The dissemination and communication activities have been closely monitored and coordinated by the Dissemination leader in order to keep track of all on-going activities. In order to measure the impact of the conducted activities, a set of metrics has been developed and presented in the Dissemination Plan (D7.3). Such metrics allowed us to have a constant view of the amount and the effectiveness of the dissemination activities conducted.

Performance of PhasmaFOOD communication channels and means has been analyzed through a wide array of measurement tools and software such as Google analytics, Twitter analytics, as well as page insights of Facebook and LinkedIn.

The table below presents the outcomes of the communication and dissemination activities performed in the period M19 – M36 and the actual values for the whole duration of the project:

Table 3: The outcomes of the dissemination and communication activities performed in the period M19 – M36

Type	Description	Time period	Key Performance Indicator	Actual M18-M36	Target whole project duration (KPIs) M1 – M36	Actual values M1 – M36
Visual identity and branding	Established, unique project branding and identity. Final logo and design scheme.	Used continuously	Visual identity established and maintained throughout all the publications and dissemination material	✓	✓	✓
PhasmaFOOD website	Creation and maintenance of a project website, providing information about the project aims, progress and outcomes	Continuous updates with news, progress & outcomes	Number of unique visitors	5.754	**3000**	7.344
Social Media - Twitter	Diffusing project news, keeping up-to-date and retweeting other news of interest (originating either from the following accounts or from the hashtag which are monitored)	Continuous	Number of followers	100	**300**	131
			Number of tweets/re-tweets	100	**350**	184
Social Media - Facebook	Diffusing project news, keeping up-to-date and reposting other news of interest	Continuous	Number of fans	50	**200**	95
			Number of posts/re-posts	42	200	75

Social Media - LinkedIn	Creation of the PhasmaFOOD Project Community on Sensing Technologies for Food Quality & Safety Group to engage with various stakeholders in project-based discussions	Continuous	Number of members	27	**120**	40
			Number of discussions	17	200	52
Dissemination material	Creation of dissemination material to be used by the partners	Periodically	Number of brochure versions (uploaded on the site and printed and used by the partners)	1	**2**	1
			Number of brochure(s) printed copies dispersed	500	**1000**	1.700 printed, around 1.200 dispersed
			Number of poster versions (uploaded on the site and printed and used by the partners)	1	**2**	4
Press Release	Press Releases produced and diffused to the media and other relevant contacts	Periodically	Number of Press releases	3	**8**	6
Publications	A number of publications are expected both in journals and in conferences	Periodically (as appropriate)	Number of journal publications (International referred journals) and publications in international conferences	19	**20**	42
Events' [3]Participation	Attendance, contributions and exchange of ideas with other stakeholders in face-to-face meetings, workshops, conferences.	Continuous (as appropriate)	Number of scientific conferences/workshops PhasmaFOOD participated to	19	**25**	23

	Participation/Demonstration in Exhibitions, Trade Fairs and Demonstration Events		Number of events outside Europe	1	**2**	1
			Number of Public Exhibitions/Trade Fairs/Demonstrations/industry-related events PhasmaFOOD participated to	2	**5**	1
Workshop / session organisation	Organisation of a workshop / session	As appropriate	Number of workshops organised	1	**2**	2
e-Bulletin	Project news, achievements and events diffused to interested stakeholders in the form of an electronic bulletin(s)	Periodically	Number of e-bulletins	4	**8**	6
Online questionnaires & polls in the form of Flash studies	Online questionnaires & polls in the form of Flash studies published/diffused to the focused groups	Periodically	Number of questionnaires/polls carried out	1	**2**	2
Mentions on the media and the 3rd platforms	Articles relevant to PhasmaFOOD to be published on the media and 3rd portals, including online and paper newspapers, specialized magazines, broadcasts, but also the professional specialised platforms, Cordis, relevant thematic blogs/collaboration platforms	Periodically	Number of publications on the 3rd portals	5	**10**	7
Infographics	Creating infographics depicting the project's aims (during the first year of the project) and results (during the more advanced project's phase when strong results are already available)	Periodically	Number of infographics created	1	**2**	2
Images	A set of images from the events, meetings and other activities	Continuous (as appropriate)	Number of images collected	20	**50**	> 50

Videos	Videos produced presenting the work done in the project	Periodically (as appropriate)	Number of videos created	0	**2**	8
Clustering /liaise with other projects/initiatives	Collaboration for mutual dissemination and knowledge exchange with other relevant projects & initiatives	Continuous	Number of initiatives/projects	3	**6**	5
Standardisation activities	Standardisation related follow-up actions	As appropriate	Number of follow-up actions	0	2	0

3 Report on Exploitation Activities

3.1 Exploitation and technology transfer

3.1.1 Project exploitation plan and strategy

PhasmaFOOD will strengthen the positioning of **PhasmaFOOD** consortium in key areas, such as the food quality industry and the smart miniaturised interconnected systems manufacturing. The work to be contributed to the project will augment partners' long-term experience in spectroscopy techniques and miniaturized system integration for advanced food quality sensing. It will add to partners' portfolio with respect to applied new consultancy services, solution customisation and deployment, managed services, etc. Each industrial partner expects to increase revenues as result of leading and participating in this project, revenues that are expected to be stabilised as a result of similar solutions provided by competitors.

Overall, the PhasmaFOOD exploitation strategy is built upon four cornerstones:

- Maximise the impact and benefits for European food quality stakeholders developing next generation low-priced mobile scanners.
- Establish an open database that is extensible and encourages third party food experts and researchers to integrate additional chemometric and pattern recognition algorithms and enrich the food quality metrics database.
- Create an ecosystem of food quality experts, researchers and technology providers that will evolve the technologies to support additional target food use cases and integrate more state-of-the-art sensing technology.
- Provide economic benefits and incentives for commercial project partners and other third-party vendors to exploit the project results and provide complementary services to enable ecosystem growth and sustainability.

3.1.2 Project exploitable results

PhasmaFOOD aims to provide a miniaturized, multi-parameter and programmable sensing node for food spoilage, adulteration and hazard detection through microbial activity. The system will integrate heterogeneous Visible and Near infrared spectroscopy technologies with a control electronic board which will ensure efficient cooperation between the sensing and the processing part.

A significant part of PhasmaFOOD impact relies on the capability for PhasmaFOOD products to reach pre-series commercialization, the increased publicity eventually leading to pre-industrialization. All the dissemination activities will clearly contribute to building a pool of buyers for PhasmaFOOD pre-series and industrial version and support the independent or joint

exploitation initiatives of subcomponents of PhasmaFOOD by the individual partners. PhasmaFOOD product portfolio will include various product packages that are expected to serve the needs of the identified segments, considering the competition. Overall, 3 product versions will be offered: Consumer edition, Enterprise edition and Science edition; each targeting a different segment in the market. An initial business model of PhasmaFOOD can be found in D1.3.

As low-priced mobile scanners will be increasingly available for consumers, increased amount of spectral data will be available for various analysis. This paves the way for increased quality control and food incident reporting. In cases of a food safety or quality incident, local authorities can pin-point swiftly a source or location where the food was distributed. Overall, this can lead to increased traceability of food from selling-point to consumer. Furthermore, if local authorities do suspect a quality or safety issue, consumers can be asked via mobile apps to scan their purchase of the product at home.

In the table below, we list the PhasmaFOOD exploitable outputs and present the relevant exploitation plans of the involved partners.

Table 4: PhasmaFOOD exploitable outputs and exploitation plans

PhasmaFOOD Exploitable outputs	Partners exploitation plan
Micro-NIR sensor	Development for industry: Target new markets and customers with the integrated NIR spectrometer. **(IPMS)**
Optical design for Integrated sensing subsystem	Visibility: In PhasmaFOOD, the existing sensors expertise of partners will be used to enter the field of food safety/food quality detection and strengthen the profile of the organisation in this community. **(IPMS, WINGS)**
Custom electronic boards for interfacing the spectroscopic components with the main electronic board and custom electronic board for supporting integrated sensing components	WINGS will exploit the expertise obtained in PhasmaFOOD in the design and implementation of custom electronic boards for interfacing with spectroscopic components and supporting measurements and pre-processing, in order to develop similar solutions for smart integrated embedded devices for various vertical sectors such food and water quality and other similar applications. **(WINGS)**
HW design for integrating specialized ICs (Integrated Circuits) for accelerating performance and data preprocessing	Similar to the above, WINGS will exploit the expertise obtained in PhasmaFOOD to develop solutions in smart embedded devices with characteristics of increased performance and

	hardware acceleration capabilities for specialized functionalities such as data-preprocessing and image analysis. **(WINGS)**
Mobile application development framework	Sensor-mobile application-cloud ecosystem is in basis of all **VLF** projects and services. VLF will continue to exploit SW concepts from the PhasmaFOOD project in all its IoT systems and solutions which require collection of sensory data/measurements from remote locations towards cloud platform and centralized servers.
Integrated PhasmaFOOD system	**INTRA** is expecting to acquire important technology and know-how for the design and delivery of services and platforms in the increasingly important domain of food related technologies, and the integration and interoperability of heterogeneous components. Freedom to develop: PhasmaFOOD gives **IPMS** the room to explore the synergies of our NIR spectrometer with imaging/UV-vis sensors. Thereby, we expect to identify new fields of application for our product also beyond food authentication. Enhancement of **WINGS** IoT platforms with PhasmaFOOD hardware and software building blocks. Exploit PhasmaFOOD outcomes as a basis for consulting services in **WINGS** and for new product-oriented strategies. Research done in PhasmaFOOD will allow **CNR/UTOV** better assess its expertise in food safety sensors and to acquire new competencies by collaboration with the other partners. **DLO** will explore the usage of PhasmaFOOD on emerging fraud and authenticity cases. Research done in PhasmaFOOD will allow **AUA** to better assess its expertise in food safety

	sensors and to acquire new competencies by collaboration with the other partners. **VLF** will utilize the PhasmaFOOD system for strengthening its position in the IoT solutions for food market. VLF is focused on exploiting the integrated PhasmaFOOD system within food supply chains together with VLF ChainRider private blockchain as a service technology. **FUB** has strong bonds to IoT industry which will be used to diffuse the results of the project as value-added functionalities in products further designed by the industry. The PhasmaFOOD system will strengthen the research partners technology transfer capabilities. **(All partners)** Strategic networking: Collaboration with the other partners expected to open doors for further product development. **(All partners)** As an initiative of **CNR** and **UTOV**, PhasmaFOOD partners involved in research activities will consider the possibility to use PhasmaFOOD concept and the assembled prototypes to perform general purpose spectral characterization of different objects in scientific environment. This idea is also potentially interesting to be included as part of scientific activities in Schools. **(All research partners)**
3rd Party APIs for integration of the PhasmaFOOD solution	Exploration of out-of-the-box approaches towards food fraud and authenticity. **(DLO, AUA, CNR)**
Web dashboard for accessing cloud DB, specifying new datasets and testing machine learning algorithms	Through participation in the PhasmaFOOD project, partners will have the opportunity to validate its reactive and proactive decision-making engines and prove importance of edge processing in complex data analysis systems. **(VLF, INTRA, WINGS).** The PhasmaFOOD solution is flexible in a sense that it allows

	definition of new use cases not necessarily in food industry, but any domain where application of spectrometry for material/product classification is applicable.
Data analysis and machine learning playground for configuring custom analysis pipelines on available reference datasets and validation of these pipelines with a set of performance metrics.	**VLF** will exploit the PhasmaFOOD ML playground and supporting technologies to build online service and marketplace for high quality reference datasets from various domains (not just PhasmaFOOD related). Add know-how and expertise on developing improved embedded software and algorithms for performance optimization and data-preprocessing will be exploited from **VLF, INTRA, FUB** and **WINGS.**
Data collection for database population	**Use case partners** will maintain the PhasmaFOOD spectral databases and will involve control authorities and private companies by either delivering customer specific databases. **(AUA, CNR, DLO)**

3.1.3 Technology transfer strategy

Detailed technology transfer strategy is presented in D7.5 "Technology Transfer, Impact and Innovation Directory". This strategy is divided into technology transfer directories for:

- PhasmaFOOD sensing sub-unit;
- PhasmaFOOD sensing device hardware – electronics;
- PhasmaFOOD cloud platform;
- Supporting chemometric algorithms;
- Reference datasets;
- Integrated PhasmaFOOD system.

Directories are presented as tables listing exploitable items/modules and description of exploitation potential as part of integrated PhasmaFOOD solution and as stand alone. For each of these exploitation directories we have described the nature of know how (is it proprietary, open source, available for licensing), described in-house manufacturing capabilities (from perspective of project partners and 3rd party integrators willing to develop PhasmaFOOD system) and listed alternatives for large volume manufacturing (which components can be replaced or implemented differently with commercially available substitutes or open source software).

3.2 Innovation and impact

The PhasmaFOOD innovation strategy comprises the following main objectives:

- Project partners are closely monitoring the main technical outcomes and achieved performance results. The goal is to identify market potential, possible stakeholders and joint or individual exploitation opportunities (exploitable results are presented in the previous section).
- Engagement with identified stakeholders in the food industry and beyond. We have prepared questionnaires for engaging stakeholders and organized direct meetings with them to investigate their needs for solutions which the project is producing.
- Through engagement of market, stakeholder and broader domain representatives, the consortium members collected specific requirements, suggestions and remarks which were translated into the solution architecture while building the final system prototype.

The PhasmaFOOD innovation strategy was built with focus on the food domain and its needs for efficient solutions for food quality and safety analysis. However, the PhasmaFOOD solution can be used in any domain which can benefit from spectrometry applied to any type of material or goods. If the sensors integrated in the PhasmaFOOD sensing device can provide sufficient information for successful classification and recognition of material properties, the whole system can be reused and adapted to new use cases and application domains. Moreover, the PhasmaFOOD cloud platform can be reused in other solutions which require collection of measurement data (agnostic to the sensor nature) from remote sources, quality and validation staging process, building high quality reference datasets from validated data and configuring high performance analysis pipelines based on the reference datasets.

3.2.1 Innovation potential

Throughout the course of the project, the consortium members closely monitored project's technological achievements and results and based on them derived a list of the main innovative project outputs (see Table 5).

Table 5 - PhasmaFOOD project innovation outputs

Innovative project output	Description of innovation step
Micro-NIR sensor	Application of prototype miniaturized NIR sensor in the project use cases was investigated and its performance are confirmed.
Optical design for integrated sensing subsystem	Designed optics apparatus is innovative since it is the first solution which enables integration of NIR, VIS-UV spectrometers with corresponding lighting sources as well as CMOS camera. More details can be found in D2.4 and D5.4.

Integration of NIR, UV-VIS and CMOS camera into single sensing device	This specific integration of two spectrometers and a camera into single device is innovative since there are no similar solution in the market. This integration means that the PhasmaFOOD system can be applied in various food and material analysis challenges which would require usage of at least three separate devices and supporting systems to achieve the same performance and extensiveness of collected data. More details on the integrated solution can be found in D6.3.
Universal system for building high quality reference datasets based on spectrometry and imaging	As mentioned at the beginning of this section, the PhasmaFOOD system can be used for other food analysis use cases and in various other domains (outside food domain) requiring spectrometry-based material analysis. Its principal purpose is to enable building of high-quality reference datasets based on measurements collected by integrated spectrometers and camera.
High quality reference datasets	The PhasmaFOOD project produced a number of reference datasets for all three project use cases. Each reference dataset corresponds to a specific food/sample type. Throughout the project these datasets have been refined and validated (through training and validating data analysis algorithms, benchmarking with legacy laboratory-based solutions) and thus represent one of the main outputs of the project. The lack of high-quality reference datasets is a major issue in the food analysis domain, and the PhasmaFOOD project addresses it by providing its validated reference datasets as well as by providing a system to help build and validate new high-quality datasets. See D3.6 for details.
Data fusion for improved performance of chemometric algorithms for food analysis	Since the system produces single measurement comprising readings in VIS, FLUO and NIR spectra as well as camera image, one of the main challenges was to implement proper data fusion techniques which may enable chemometric algorithms to benefit from the extended data (compared to classing single-spectrometer systems). Our approach was to apply mid-level fusion of measurement data from all three spectrometers and perform use case and sample specific feature selection on such fused data. The camera image is used to identify position of a focus point. Further usage of the camera image in conjunction with the spectrometer data will be evaluated and reported until the end of the project.
Data analysis distributed between three system layers	Measurements collected with a single cycle of the PhasmaFOOD sensing device represent extensive set of data which requires significant resources for proper processing to extract actionable information. This is why we have decided to distribute data processing across all three system layers through which the data are passing. The PhasmaFOOD system performs data collection, formatting and preprocessing on the embedded system (residing on the sensing device). It also compresses the camera image. The mobile application performs averaging on collected raw measurements. Finally, the cloud

	platform applies configured data analysis pipeline comprising methods for dimensionality reduction and feature selection and finally an estimator model. Once best performing analysis pipelines for each project use case and sample type are identified and validated, we will consider deploying trained models or performing specific data transformation operations on embedded and mobile app layers. More details can be found in D6.3 and D4.2.
Utilizing end user mobile device as communication bridge and UI interface for device	The goal was to avoid increasing complexity and cost of the sensing device by integrating display supporting rich UI and communication interfaces for direct access to the Internet. Therefore, we have followed a modern IoT paradigm – whenever possible include end user smartphone (or other mobile device) into the information and decision-making flow. With PhasmaFOOD mobile application[4] we have provided communication bridge and easily configurable and cost-effective approach for providing rich UI for the sensing device. Through mobile app development tools and practices, any updates to the communication APIs and user interfaces can be easily distributed to all users. Also, different stakeholders may require different interfaces which can be easily supported with specialized instances of a white-labeled application. More details on the mobile application can be found in D4.2.
Open APIs for 3rd party integrators	We have developed extensible set of REST APIs which enable 3rd party integrators to utilize the PhasmaFOOD solution and build custom applications and services based on provided resources and functionalities. This ensures that the PhasmaFOOD system can live after the project and be successfully exploited by the project partners and identified stakeholders. More details can be found in D4.2 and D6.3. Interactive API documentation is also provided[5].
ML playground[6] for customizing data analysis pipelines	In order to streamline configuration and validation of the custom data analysis pipelines applied to PhasmaFOOD reference datasets, we have implemented an innovative web application and set of services which enable: 1. Querying available reference datasets; 2. Configuring each step of analysis pipeline (based on supported scikit-learn functions); 3. Triggering model training and applying cross validation; 4. Comparing performance metrics of newly configured analysis and pipeline with is currently active as part of the decision making rule engine. The ML playground is still work in progress and will be in alpha version in December 2019. More details can be found in D4.2.

[4] https://play.google.com/store/apps/details?id=com.vizlore.PhasmaFOOD
[5] https://phasma-v2.xyz/documentation/
[6] https://dashboard.PhasmaFOOD.eu/dashboard/playground

Customizable rule engine for decision making	The rule engine applies trained and configured data analysis pipeline based on information available in the provided measurement (use case and sample type). In order to streamline the maintenance and ensure that best performing pipelines are included into the rule engine, we have implemented a mechanism which enables users with administrative role to make a newly configured and validated pipeline in the ML playground an active one in the decision-making rule engine. This way we have ensured that with updated reference datasets we can periodically configure new pipelines and compare their performance with respect to the ones which are active in the decision-making system, thus ensuring that the performance of the overall system is constantly improved. More details on this mechanism can be found in D4.2.

Furthermore, the consortium has investigated potential for application of the PhasmaFOOD system in managing complete food supply chains. More details on potential usage of the PhasmaFOOD system in supply chain management, trust platforms (through integration with blockchain technologies) and integration with other process and product monitoring systems can be found in D7.5.

3.2.2 Stakeholders and outreach

At the start of the project we have identified the following groups of stakeholders which we engaged during the project:

- Research institutes, academic laboratories and research projects;
- Food industry – all supply chain actors, food safety, photonic technology providers, smart electronic design providers, IoT service providers and application developers;
- Regulatory bodies responsible for monitoring food quality and safety through regular inspections and random sampling;
- The general public.

We have prepared an online questionnaire[7] for collecting inputs from potential stakeholders. Apart from that, identified key stakeholders are also directly engaged and interviewed on how they would utilize a system like PhasmaFOOD. Key information provided by 8 stakeholders (at the moment of writing of this document) which have finalized the questionnaire are presented in the D7.5.

Apart from the questionnaire, project partners have directly engaged key stakeholders from the industry (see Table 6). Each stakeholder provided their insight into the PhasmaFOOD solution and

[7] https://docs.google.com/forms/d/e/1FAIpQLSc9sUIZOW8b69LUBdQfzRikwRbzEcGWGDCpWdQh0SaEhyv8pg/viewform?usp=sf_link

discussed their requirements with respect to food safety and quality analysis. Some of the stakeholders also indicated that they would like to do experiments with the PhasmaFOOD system once it is ready (probably in laboratory of one of the project partners).

Table 6: PhasmaFOOD project stakeholders

Stakeholder	Interest in PhasmaFOOD solution	LoS
Barilla (IT)	Interested in mycotoxin and acrylamide detection in pasta production processes and biscuit product lines. Barilla is interested in integrating the PhasmaFOOD device into their experimental production lines where they test and validate innovative technologies before deciding to include them into their production facilities.	Yes
Birra del Borgo (IT)	Association of beer producers of Rome are one of the first project stakeholders. They are interested in applying the PhasmaFOOD solution for detecting mycotoxin levels in beer ingredients.	Yes
Hamamatsu Photonics (JP)	Also one of the first project stakeholders. PhasmaFOOD project utilizes Hamamatsu UV-VIS spectrometer so they are very interested in our validation results and receiving potential feedback on how to further improve the solution.	Yes
YIOTIS (GR)	Large food producer from Greece. They are interested in applying the PhasmaFOOD system as integral part of the production line for baby food. They have expressed interest for performing experiments on their reference samples with the PhasmaFOOD system.	Yes?
BfR (DE)	Regulatory agency from Germany. They are interested in application of the PhasmaFOOD system for supply chain regulations and food authenticity check (focus on wine).	Yes
Origin Trail (RS)	This SME from Serbia and Slovenia provides solutions for agri-food traceability throughout supply chains. They are interested in joint demo with VLF from PhasmaFOOD consortium on integration of the PhasmaFOOD system with the blockchain based trust management platform of Origin Trail.	No
Megas Yeeros (GR)	This meet producer from Greece is interested in application of the PhasmaFOOD system in spoilage and authenticity analysis for meets especially minced meets.	Yes?
FROSTA (DE)	Fish production and processing company from Germany assessed applicability of the PhasmaFOOD system in their production processes. We have jointly identified a new requirement and challenge for the PhasmaFOOD system - analysis of frozen food.	Yes?

Danone (FR)	Company engaged WUR and want to perform experiments on their reference samples for milk products. Joint experiments are still in plan.	Yes
Nurideas (IT)	Potential integrator of the PhasmaFOOD system in IoT systems for agrifood sector. They are interested in the PhasmaFOOD solution since it is the only open platform which integrates multiple spectrometers and a camera.	Yes?
Green Bio Industries (US)	Strong interest in applying the PhasmaFOOD solution for mycotoxin detection in industrial hemp.	No

Project partners are analyzing requirements of all stakeholders. The plan is to prepare one specialized instance of the PhasmaFOOD solution (first of all specialized instance of the PhasmaFOOD mobile application) which addresses specific needs of one of the stakeholders. The specialized instance will focus on detection of adulterated skimmed milk powder samples. This scenario is appropriate for public demonstration. This way the consortium will demonstrate flexibility of the developed solution and how it can be adapted to specific industry needs in cost effective manner.

3.2.3 Project impact

The main impact of the project is development of a system which enablers collection and validation of high-quality reference datasets and building data analysis models based on them. Within PhasmaFOOD we have utilized this system to build reference data sets and chemometric algorithms for the three use cases: mycotoxin detection, food spoilage and shelf life estimation and food adulteration.

Table 7, presents list of targeted impacts and what are the project achievements which can be mapped on the targets.

Table 7: PhasmaFOOD project impact indicators

Target impacts	Achievements of the PhasmaFOOD project
Availability of new generations of miniaturised smart systems with significant improvements in performance	The PhasmaFOOD portable sensing device combine multiple sensors, CMOS camera and lighting sources and integrates them into a single system for food analysis in various use cases. A miniature NIR spectrometer integrated in the project prototype. To the best of our knowledge, the PhasmaFOOD system is unique on the market and it provides opportunities to explore potential behind data fusion for measurements coming from VIS, NIR and FLUO sensors as well as RGB camera. The PhasmaFOOD device produces analysis results in 2-3min

	compared to 4-5 hours how long it takes to standard laboratory procedures to produce results. The PhasmaFOOD system is also portable which makes it appropriate solution for field and in-line usage which would allow field inspectors to pinpoint samples for further laboratory analysis instead of random sampling. See details in D2.4 and D6.3.
Reinforced industrial technology leadership in next generation smart systems with high market potential	PhasmaFOOD project developed an integrated system for collecting and validating high quality reference datasets and training models on these datasets. It can be applied in any industrial sector which requires spectrometry and image-based material analysis. In previous section we have listed all stakeholders engaged during the project. The listed stakeholders as well as other company and institutional representatives (i.e. those who visited our demo booth at RAFA 2019), find the PhasmaFOOD solution to be uniquely suitable for food quality and safety inspection at different steps in food supply chains (from production to consumption). The PhasmaFOOD system can also target small food producers who cannot afford to establish their own inspection laboratories and thus rely on the laboratories of large industry who they are supplying. With PhasmaFOOD system, small food producers can perform quick quality and safety assessment during harvest, shipment preparation and during warehousing. For large food industry, PhasmaFOOD solution can be used as in-filed or in-line food inspection tool for identifying best samples for further laboratory analysis. Food safety and quality assurance regulatory bodies can supply their field inspectors with PhasmaFOOD-like solution for targeted sample collection instead of random sampling. Finally, the PhasmaFOOD solution can be used outside the food domain as well. Any type of material (construction material, pharmaceutical ingredients etc.) that can be classified and inspected with the integrated sensing technologies can be used for collecting reference datasets and training custom classification models. D1.3 identified a wide variety of segments and markets for each project use-case. It also provides a preliminary framework for the final PhasmaFOOD product and value proposition.
Business growth and increase competitiveness by	The PhasmaFOOD smart food analysis platform allows for the same sensing solution and platform to be used at all stages of

strengthening cooperation along the value chain	food production, distribution and consumption. See section 3.1.1 of D7.5 for details on potential application of the PhasmaFOOD project for trust management and food safety and quality monitoring throughout food supply chains.
Increased industrial investment in smart system integration technologies	Section 2.2.2 lists all stakeholders engaged during the project and outcomes of discussions with them. There is strong need for PhasmaFOOD-like solution in the food industry and especially as solution for regulating and monitoring food supply chains.
Provide innovative solutions for addressing societal needs and expectations in particular for the health and well-being, safety and security and environment	The PhasmaFOOD smart food analysis system address the need of people for quality and safe food and allow them to assess these aspects of food directly without the need for cumbersome laboratory analysis. Outcome of the project will be solution which is TRL4. Next stage of development will bring the solution to industrial partners and higher TRL (7-8). After that the goal should be to commercialize an instance of the solution for end consumers (these are beyond project plans). Placing the PhasmaFOOD devices and platform instances throughout food supply chains will improve food safety, traceability, transparency and general food quality awareness.

4 Data Management Plan - updates

The deliverable D7.2 “Data Management Plan” is updated as planned and included in full as an Annex II in this deliverable.

This updated version will be also made public via the project’s website.

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

5 Conclusions

This report provides an overview of the dissemination work carried out by the project during the period from M19 (July 1st, 2018) to M36 (December 31th, 2019).

This deliverable reports on the dissemination & communication activities implemented by the PhasmaFOOD project, outlines the detailed project exploitation activities and provides an updated Data Management Plan for the same period which has been included in the Annex II of the deliverable.

PhasmaFOOD has produced a detailed dissemination strategy and plan (presented in the deliverable D7.3 “Dissemination Plan”), an internal instrument to provide a consistent framework for all activities needed to disseminate and sustain the concepts, achievements, as well as technical and knowledge results developed within the project.

The main achievements of this period in relation to dissemination are the updated sections of the project website considering it as a high-quality dissemination channel with an increasing number of visitors, the growth of the project’s social media channels, the number of publications submitted/accepted, the great number of quality events that the project was showcased in various ways and the establishment of a strong brand identity for the project. A number of important relationships have been established with related projects and initiatives.

With regards to the events-based dissemination, the project partners participated during the second half of the project (with presentations, scientific publications, poster presentations and networking activities) in 20 events (one outside Europe). The project’s high-quality promotional material prepared during the first months (brochure, poster, identity pens and bags) have been widely used and disseminated during the events. Updated events and results-oriented press releases and newsletters were created and shared via our website, social media and other media channels/networks. 3 new scientific posters have been prepared and presented during our participation to major events.

Strong linkages and cooperation have been created and maintained with the three new relevant Horizon 2020 projects as well as with the Micro-Nano-Bio Systems (MNBS) cluster of EU-funded projects.

Innovation and Exploitation related activities were presented in Section 2 of the deliverable. The detailed project exploitation plan and strategy has been updated with the contribution of all partners, while the PhasmaFOOD exploitable outputs and the relevant exploitation plans of the involved partners are expected to maximise the impact and acceptance of PhasmaFOOD concept and developed technologies.

Innovation strategy has been updated with focus on achieving high impact in technical, scientific and business domains related to food analysis, IoT systems and spectroscopy-based systems. The PhasmaFOOD integrated system prototype has been demonstrated to identified stakeholders in

various events and in collaboration with them we have assessed business impact of the project results and opportunities for further growth.

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

Annex I: Press Releases and announcements

PhasmaFood

PRESS RELEASE

Sensing FOOD for SAFETY

The prototype PhasmaFOOD Multisensor Food-Scanning Device is ready!

The PhasmaFOOD consortium proudly announces that the first integrated PhasmaFOOD prototype device is now fully assembled, functional and is ready to be used in the first phase of validation and calibration activities of the project.

The PhasmaFOOD sensing device integrates a sensing node and an electronic subsystem. A sensing node conducts the sensory measurements on the food samples and includes an Ultraviolet-Visible (UV-VIS) spectrometer, a Near-Infrared (NIR) spectrometer, a camera, and Ultraviolet (UV), white and NIR illumination sources. An electronic subsystem supports the operation of the sensing node by controlling the sensing measurements, collecting the sensory data, partially processing them and sending them to the end user's mobile device. The mobile device communicates the sensory data and contextual information to the cloud platform for further analysis. The cloud platform returns to the end user (at their mobile application/screen) the final decision on their scanned food sample.

PhasmaFOOD food quality partners will now be able to use the PhasmaFOOD prototype in order to collect information and experimental data allowing the continuation of data analysis and the completion of experiments for all use cases.

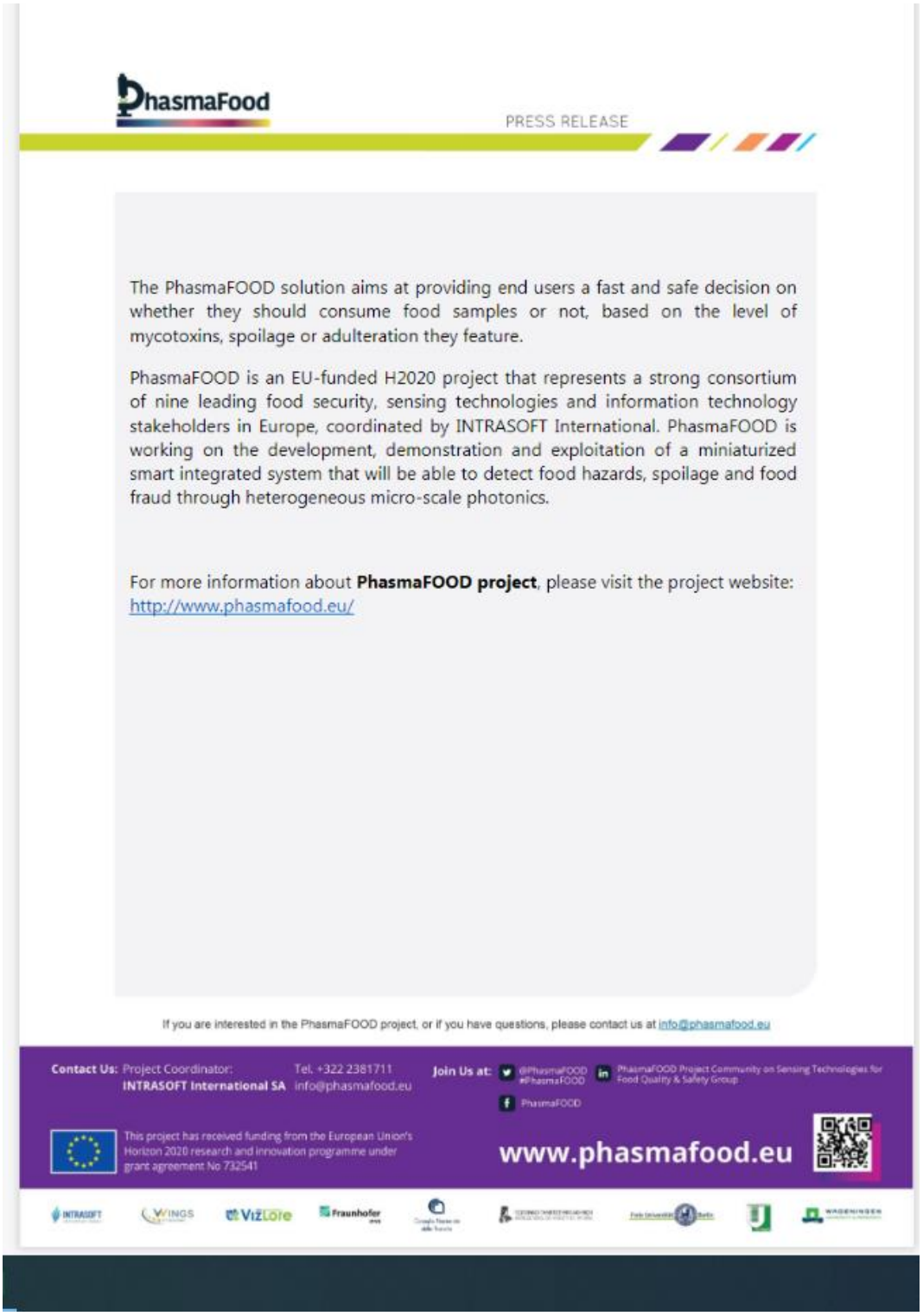


Figure 13: The prototype PhasmaFOOD Device announcement

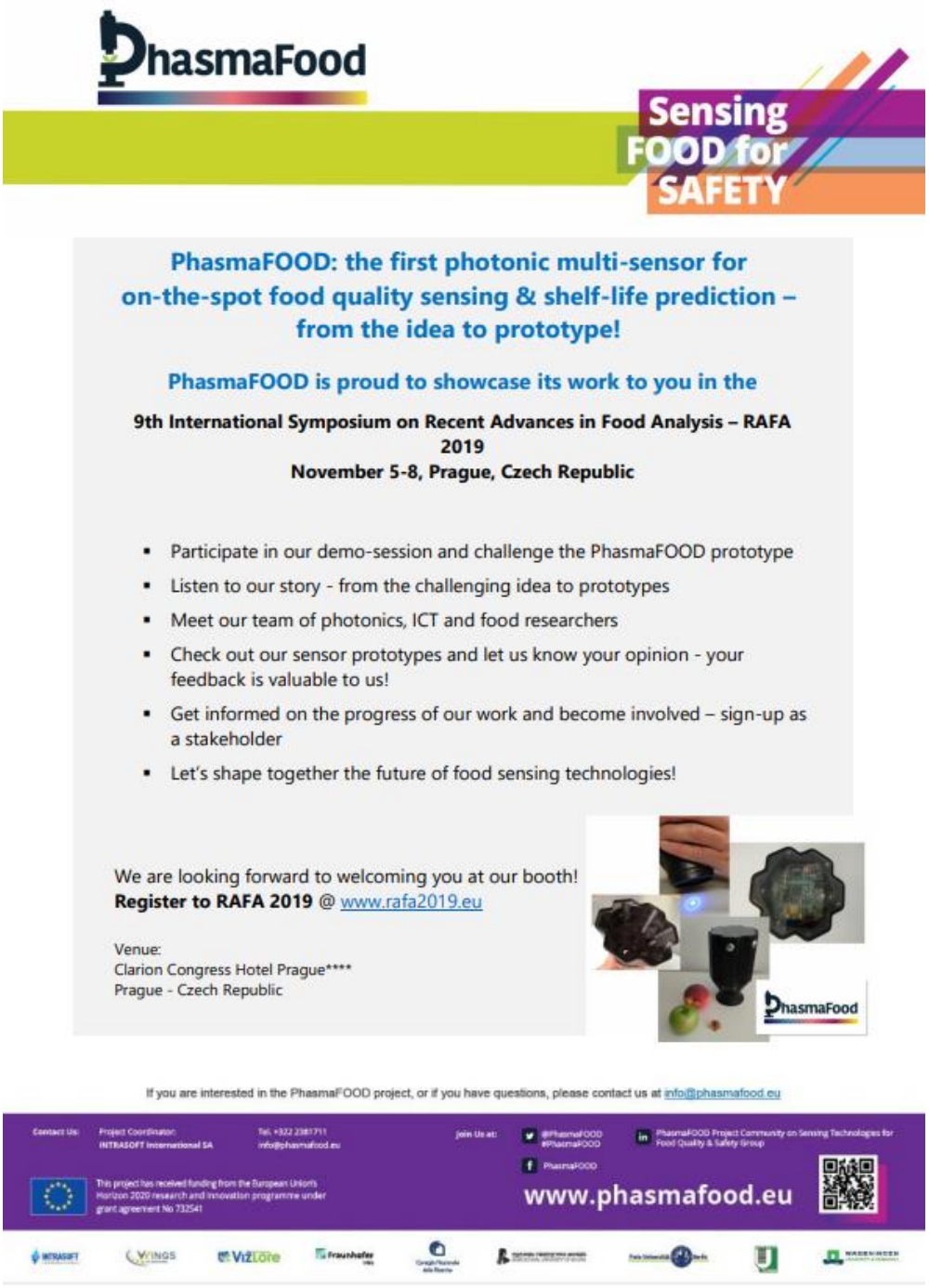


Figure 14: PhasmaFOOD Announcement for RAFA 2019 in Prague (November 2019)

PhasmaFood

Sensing FOOD for SAFETY

PhasmaFOOD: the mini-portable smart system for on-the-spot food-quality sensing & shelf-life prediction at RAFA 2019

PhasmaFOOD showcased its results at the 9th International Symposium on Recent Advances in Food Analysis

November 2019

PhasmaFOOD showcased its results at the 9th International Symposium on Recent Advances in Food Analysis -RAFA 2019 which took place between 5-8 November 2019, in Prague. An international meeting bringing together food scientists from academia and industry, national and international agencies, control authorities and governmental and commercial laboratories.

During the RAFA symposium, **Spyros Evangelatos,** the project coordinator from **INTRASOFT International,** introduced **PhasmaFOOD** project to the audience. His presentation was focused on the project's main goals and objectives targeting the on-the-spot food quality sensing. Apart from the implementation roadmap from the early stages of the project, a brief description of each use-case that has been tested within **PhasmaFOOD's** lifespan was given highlighting the promising results and comparing them with the use of only one spectroscopy technology.

Konstantinos Tsoumanis, from Wings ICT Solutions, presented the hardware part of the **PhasmaFOOD** project placing special focus on the sensing node and the supporting electronics parts of the sensing device. The sensing and lighting components of the sensing node were presented, as well as the electronic board, which controls the operation of the sensing device and was designed and developed from the start tailored to the needs of the project. The technical challenges of developing the embedded software at low and high level were also presented. Along with **Yannick Weesepoel** from **Wageningen Food Safety Research,** they also pointed out the challenge of making various engineering domains to collaborate in order to deliver the final system, as well as the challenging yet interesting part of discussions between ICT partners and food laboratories throughout the project since two generally different "worlds" had to communicate each other.

Figure 15: PhasmaFOOD at RAFA 2019 in Prague (November 2019)

PhasmaFOOD Workshop: the role of Information Technology and Process Analytical Technology in assessing Food Quality & Safety

December 2019

The workshop organized by PhasmaFOOD took place on Friday, November 2019 at the Agricultural University of Athens, Greece.

Ms. Vasso Papadimitriou representing SEVT, the Greek Food & Drink Industry on national, European and international level which consists of food and drink companies and sector associations, has officially opened the workshop and described the Federation's work, role and mission. Her presentation focused on the active collaboration with the members of the Federation to continuously strengthen the industry by producing safe and healthy quality products in Greece and abroad. In this context, Ms. Papadimitriou expressed her high interest in the PhasmaFOOD device as an innovative tool for quick field inspections which may have a huge impact on the everyday life of the citizens.

The workshop presented the project progress and the prototype PhasmaFOOD device to an open audience. Complementary sessions were included presenting the broader spectrum of IT-supported advances readily applicable to quality and safety. Alexandra Lianou from the Agricultural University of Athens, made an introduction to Process Analytical Technology in the Food Industry. Milenko Tosic from VizLore Labs Foundation focused his presentation on the application of blockchain technologies in food industry while Paraskevas Bourgos, from WINGS ICT Solutions made an introduction to the concept of non-invasive methods of food analysis and presented the current status and the 2nd prototype use case measurements progress.

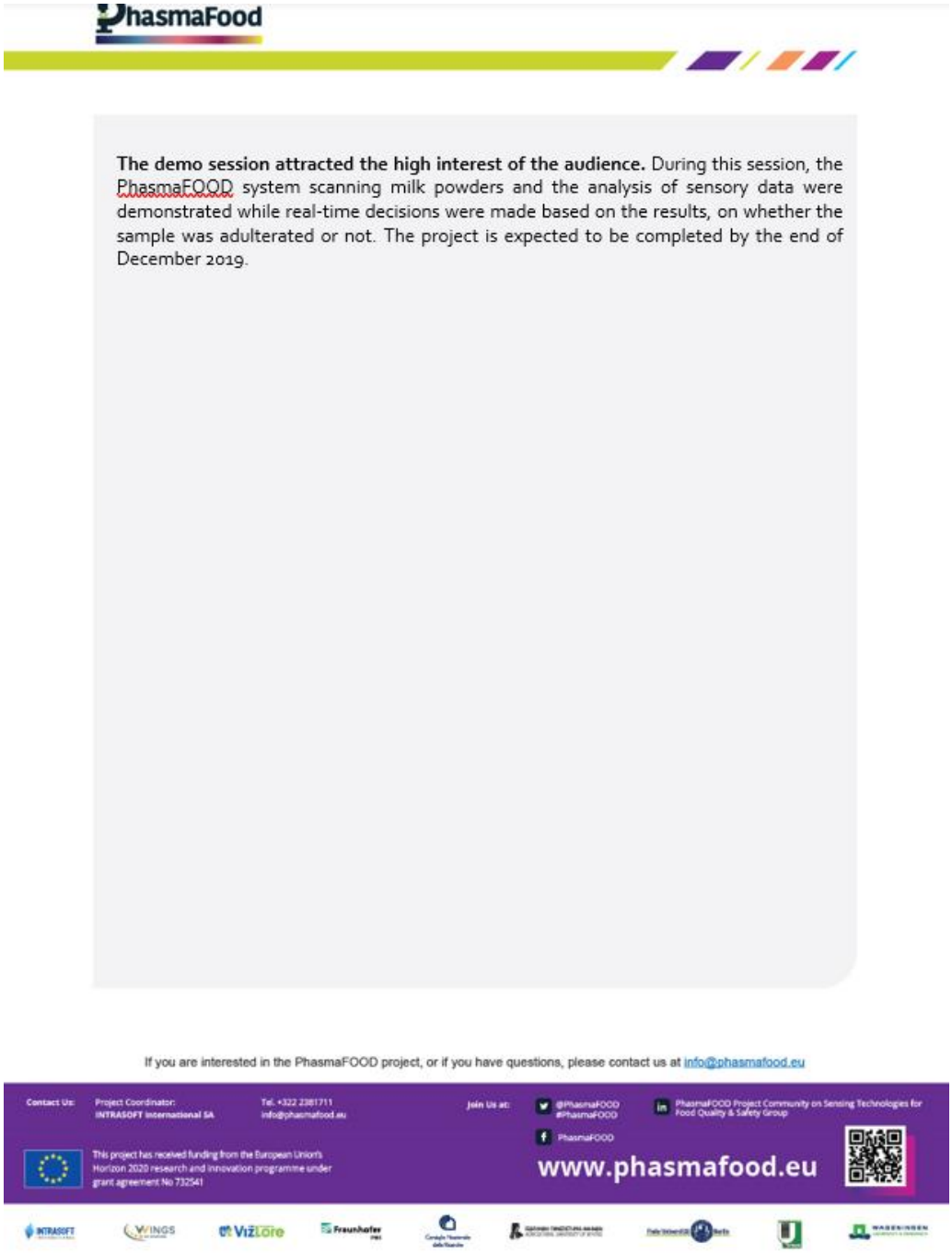


Figure 16: The PhasmaFOOD Workshop at the Agricultural University of Athens (November 2019)

Annex II: Data Management Plan (update M18-M36)

Project Acronym: PhasmaFOOD
Grant Agreement number: 732541 (H2020-ICT-2016-1 - RIA)
Project Full Title: Portable photonic miniaturised smart system for on-the-spot food quality sensing

DELIVERABLE

Deliverable Number	**D7.2**
Deliverable Name	**Data Management Plan (update M36)**
Dissemination level	PU - Public
Type of Document	REPROT
Contractual date of delivery	31/12/2019
Deliverable Leader	INTRASOFT International
Status & version	Final, V1.0 – 18/12/2019
WP / Task responsible	INTRASOFT International (INTRA)
Keywords:	Data Management Plan, data accessibility, data repositories, data interoperability, security, Metadata Standards.
Abstract (few lines):	The deliverable describes the data management life cycle for the data to be collected, processed and/or generated by PhasmaFOOD.

Deliverable Leader:	Spyros Evangelatos (INTRA)
Contributors:	Spyros Evangelatos(INTRASOFT), Yannick Weesepoel (RIKILT), Gerhard Wunder (FUB), Annamaria Gerardino (CNR), Prof. George Nychas (AUA), Susanne Hintschich (IPMS), Paraskevas Bourgos (WINGS), Milenko Tosic (VLF), Ioannis Daskalopoulos (INTRA), George Tsoumanis (INTRA)
Reviewers:	Gerhard Wunder (FUB), George Nychas (AUA), Paraskevas Bourgos (WINGS)
Approved by:	Spyros Evangelatos (INTRA)

Executive Summary

This deliverable reports the data collecting and sharing plan in the scope of the PhasmaFOOD project. PhasmaFOOD will design and implement a parameterized, knowledge-based, multi-target food sensitive mini-portable system for on-the-spot food quality sensing and shelf-life prediction. The miniaturized smart integrated system will collect spectra and images via heterogeneous micro-scale photonics. The data will be forwarded to the cloud where the spectroscopy analysis will take place using a reference database. The PhasmaFOOD reference database is built upon laboratory measurements of specific foods and qualities supported by the PhasmaFOOD Use Cases.

Section 3 of the current document provides descriptions of the Datasets that have been produced in laboratory experiments specifically set up in order to collect reference measurements. These dataset descriptions provide useful insight on laboratory experiments about the food types considered within the PhasmaFOOD interests and may be useful in other food security settings outside the project.

Furthermore, considering the IT system aspects of PhasmaFOOD, Section 4 provides a brief overview of related metadata standards that have been employed during the system design and implementation in order to advance the interoperability of PhasmaFOOD with existing procedures, systems and services of the food safety domain.

The remaining sections provide the detailed viewpoints of the Data Management Plan addressing: Naming methodology (Section 2.1); Data Access and Sharing (Section 5); Database Characteristics (Section 6) and Archiving and Preservation (Section 7.1).

This document represents an update to the initial Data Management Plan produced in M4 of the Project and aims to highlight and report progress until M18. In this version, additional food and beverage measurements related to all PhasmaFOOD use cases are presented. Information and Data regarding software design and implementation (cloud, mobile and embedded level) has also been included. The next update of this document is planned for M36 and will reflect further changes in the data management framework of PhasmaFOOD.

Document History			
Version	**Date**	**Contributor(s)**	**Description**
0.1	8/12/2019	INTRA	1st preliminary version
0.2	9/12/2019	INTRA	Request for partners contributions to the updated deliverable
0.3	17/12/2019	INTRA, ALL	2nd preliminary version including comments from internal review
0.4	18/12/2019	INTRA, AUA, WINGS, FUB, IPMS	Final Approval, QA
1.0	18/12/2019	INTRA	Final document for submission to the EC

Table of Contents

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

List of Tables

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

Table of Figures

Definitions, Acronyms and Abbreviations

Acronym	Title
API	Application Programming Interface
CO	Confidential, only for members of the consortium (including Commission Services)
CR	Change Request
D	Demonstrator
DL	Deliverable Leader
DM	Dissemination Manager
DMS	Document Management System
DoA	Description of Action
Dx	Deliverable (where x defines the deliverable identification number e.g. D1.1.1)
EIM	Exploitation Innovation Manager
EU	European Union
FM	Financial Manager
MSx	project Milestone (where x defines a project milestone e.g. MS3)
Mx	Month (where x defines a project month e.g. M10)
O	Other
P	Prototype
PC	Project Coordinator
PM	partner Project Manager
PO	Project Officer
PP	Restricted to other programme participants (including the Commission Services)
PU	Public
QA	Quality Assurance
QAP	Quality Assurance Plan
QFD	Quality Function Deployment
QM	Quality Manager
R	Report
RE	Restricted to a group specified by the consortium (including Commission Services)
STM	Scientific and Technical Manager
TL	Task Leader
WP	Work Package
WPL	Work Package Leader
WPS	Work Package Structure

1 Data Summary

The main objective of PhasmaFOOD is to design and implement an autonomous, multifunctional and programmable optical sensing device, integrated with spectroscopy technologies for food hazard, microbial activity detection and shelf-life estimation.

The project will configure a dedicated cloud platform for collecting data from the PhasmaFOOD device and to perform in-depth analysis of the data obtained from the project's device. The cloud platform will enable correlation of the device measurements with spectral analysis results collected from all connected PhasmaFOOD smart sensing devices. This will provide the opportunity for detection of trends, patterns and distribution of food contamination which can help prevent outbreaks and provide recommendation for improving food safety at different stages of farm-to-fork production chain.

PhasmaFOOD cloud platform will also host sensory and contextual database which will be used for training data analysis and machine learning models deployed on smart sensory device and as part of PhasmaFOOD mobile application (data analytics calibration). The data collected from the miniaturized device will be forwarded to the cloud where the spectroscopy analysis will take place using a reference database. The PhasmaFOOD reference database will be built upon laboratory measurements of the specific foods and qualities supported by the PhasmaFOOD Use Cases:

- **Use case 1: Detection of mycotoxins in various grains and nuts:** Aflatoxins, a special type of mycotoxins, will be detected. A simple, convenient ultraviolet test makes it possible to detect the possible presence of aflatoxin.
- **Use case 2: Detection of early sign of spoilage and spoilage in fruits, vegetables, meat, fish**: Combined with estimation on product expiration date.
- **Use case 3: Detection of food fraud:** Adulteration of alcoholic beverages, oil, milk and meat.

Deliverable updates are planned for Months 18 and 36 to reflect the updates in the data management framework of PhasmaFOOD.

2 Datasets: Reference and Name

The PhasmaFOOD project has already identified, and is still further identifying, a set of data sources that will stem from new and existing laboratory experiments that will produce the required reference measurements required by the use case scenarios.

Following an iterative process, data sources are established, encapsulating the project's use case requirements. A refinement process is foreseen to continuously take place throughout the lifetime of the project, as new laboratory experiments will be deployed to collect additional reference measurements.

2.1 Naming Methodology

2.1.1 Folder nomenclature

For each data source there are folders containing the data source definition and the data sample. Each folder has a specific name that contains information. The folders are being displayed according to the folder tree:

- Use Case (UseCase1, UseCase2, UseCase3),
- Lab (WAG, AUA, BARI),
- Food Type (Almond, Maize),
- Replicate (Replicate1, Replicate2),
- SampleID (Sample1, Sample2, A, B),
- Temperature (4C, 8C, 12C, Dynamic),
- Exposure Hours (0h, 14h, 24h, 34h, Dynamic),
- Sensor (FLUO, NIR, MSI_IMG, VIS, MICRO, AFLATOXIN)

Based on the above, a data source folder instance example would be:

UseCase1/WAG/Almond/Replicate1/Sample1/Dynamic/Dynamic/VIS

2.1.2 Datasets nomenclature

Each sensor folder contains csv files which are the measurement datasets. Adding field information required for the further identification of the datasets. For each dataset in each sensor folder, its specific name is composed by different parts:

- FLUO csv files are for example, exampleFilename_01.csv, exampleFilename_02.csv and so on. Inside the FLUO folder there must be a csv that is the _Dark reference. The filename for the Dark reference must be as follows exampleFilename_Dark.csv (end in _Dark).
- NIR csv files for example are exampleFilename_01.csv, exampleFilename_02.csv.
- VIS csv files come in triplets of e.g. (example_NN.csv, example _NN_Dark.csv, example _NN_ref.csv). It is therefore required to set the measurement number NN and follow the convention that the reference files end in _Dark and _ref.

- MICRO csv files contain information about the microbiological data for Use Case 2 measurements and must have the filename micro.csv.
- AFLATOXIN csv files contain information about the aflatoxins for Use Case 1 measurements and must have the filename aflatox.csv.

In the PhasmaFOOD data warehouse, which is part of the PhasmaFOOD cloud platform, all use case related reference datasets are organized into JSON document collections. Collections are named following this logic: *use_Case_Food_Type_v1/2*. Use case indicates one of the three project use cases, food type are types of samples used for collecting measurements and v1 and v2 correspond to measurements obtained with the 1st and 2nd system prototype respectively.

More details on organization of the cloud DB can be found in D4.2 and D3.6.

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

3 Dataset Descriptions

3.1 Generic Use Case Data Sources

In order to efficiently and adequately persist all the necessary information related to the PhasmaFOOD system, a data model (see Figure) has been iteratively produced, enriched and fine-tuned during all phases of the analysis, design and implementation of the system. Data model is defined to provide necessary flexibility for introducing additional attributes required for new data sets and use case – food type combinations. For detailed information regarding the structure of the data model components please consult the Appendix A at the end of this document, which shows reference JSON Schema. The main components of the implemented data model are as follows:

- The sample identifier – the main ID for measurements, unique across the whole cloud DB.
- The information on user and device – Set of attributes and identifiers for the measurement device and user performing the measurement. This is important for organization of the authorization groups on the web dashboard and referencing collected measurements based on the user who collected them.
- The measurement configuration – set of attributes indicating selected use case, food type, sample status (i.e. granularity, temperature) and analysis type. Also, this part of the data model includes configuration parameters for individual sensors (times, voltages, currents etc.). This sensor configuration is important for testing and evidencing different system setups in different scanning conditions resulting in implementation of "optimal" system configurations for analysis scenario at hand. In addition, sample labels are provided for laboratory personnel who conduct measurements towards building the reference data sets. These labels enable them to follow well established measurement protocols and sample identification routines thus streamlining the process of using the PhasmaFOOD device.
- The measurement data – The main portion of the reference data model are actual measurements from the integrated spectrometers. Here we have NIR, VIS and FLUO arrays of values indexed so that they correspond to predefined wavelengths at which the spectrometers are taking sample values. Together with the measurement values, the corresponding white and dark references are collected and stored in the cloud DB based on the implemented data model. Finally, the data model includes object storing data related to the obtained image coming from the integrated CMOS camera. The camera images are converted by the mobile application into Base64 encoded strings and as such transferred to the cloud platform for storing. The encoder on the cloud platform side converts these strings into .jpeg files.

This organization of the base data model for all reference data sets enabled implementation of specialized queries over stored JSON documents. For the purpose of training different steps in use case specific DA pipelines, we were able to build fast DB queries focusing on specific use case, sample type, sample state (i.e. granularity) and choose one or all spectrometer readings.

For the first integrated system prototype we have collected and stored all measurement data at the cloud database. This includes "raw"/unprocessed measurements, preprocessed/normalized measurements and corresponding references (white and dark). For all spectrometers we are collecting reflectance spectra.

Presented data model includes all necessary parameters enabling proper calibration of the measurement process and system towards implementation of specialized instances of the system focused on specific use cases and analysis scenarios.

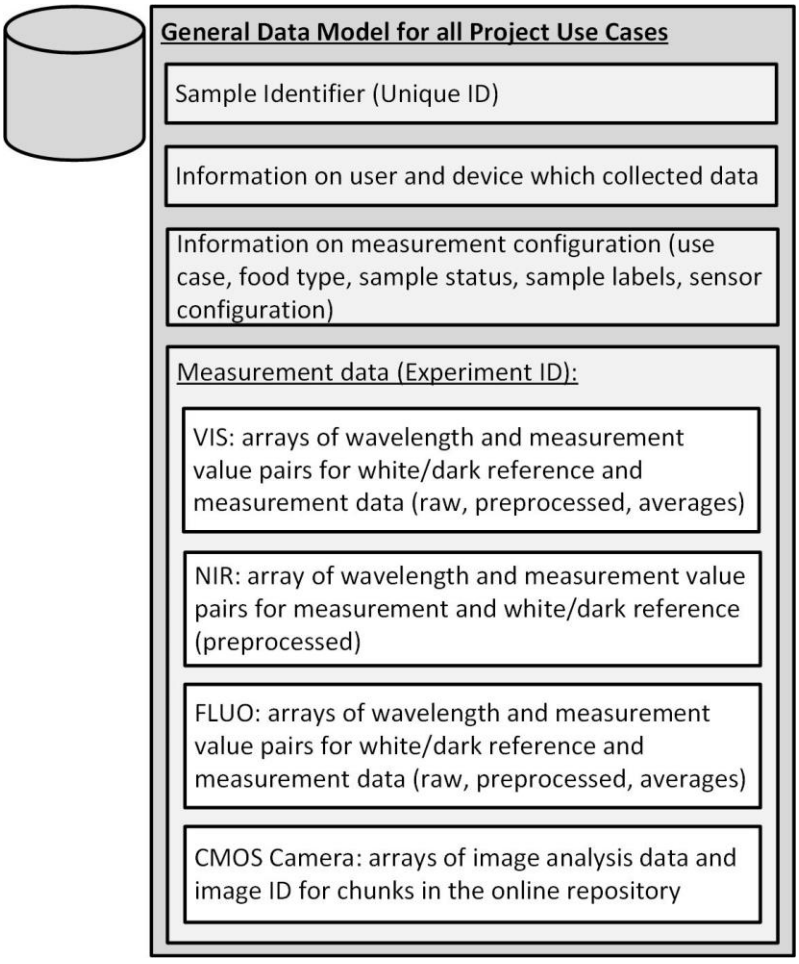


Figure 1 - PhasmaFOOD data model overview

More detailed explanation of the data model and approaches in collecting, storing and validating reference data sets during the project can be found in D3.6

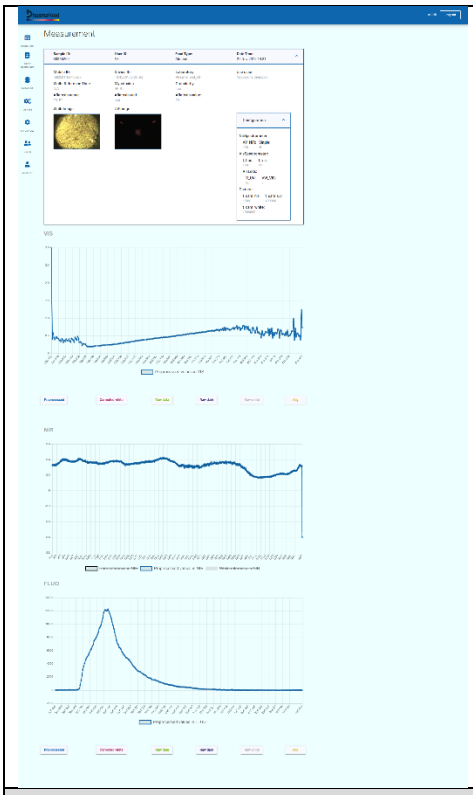
Data Source name: Use-case 1, 2 and 3
Data source description
Data, used for use-cases 1, 2 and 3 (see D3.6), populating spectroscopic databases: 1. FLUO data – spectroscopic data 2. VIS data – spectroscopic data 3. NIR data – spectroscopic data

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

4. Camera data – image data

Chemical reference data (e.g. chemical reference methods and CFU's) to benchmark the samples in use-cases 1, 2, and 3.

Dataset entities	Samples used in use-cases 1, 2 and 3 for spectral data base building (WP3) and validation (WP6)
Dataset attributes	See figure above and appendix 1.
Data type	JSON document in the reference dataset. Individual measurements can be downloaded in Excel files.
Standard	NA
Direct data URI	https://dashboard.phasmafood.eu/dashboard/dashboard-menu
Data Size	~170KB per measurement without camera image when downloaded as Excel file. ~4MB per measurement with camera image – cloud DB storage format.
Sample size	Different for project use cases and food types.
Data lifetime	WP 3 – till M 27, WP 6 till M36
Availability	Publicly available
Data collection frequency	On demand
Data quality	1st prototype – medium quality, 2nd prototype – high quality.
Raw data sample	
http://rid-redmine.intrasoft-intl.com/dmsf/files/21835/view	
Print screen (if possible)	



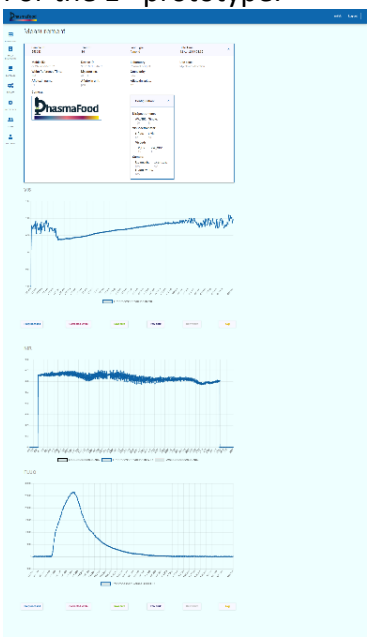
Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.) – Check Appendix 1 and D3.6.

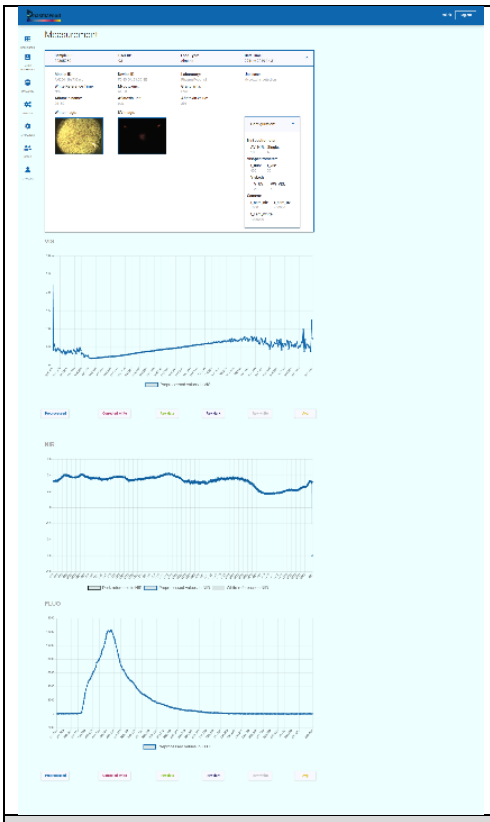
In the remaining sections, detailed instances of PhasmaFOOD laboratory measurements are presented. These will form the basis of the PhasmaFOOD cloud reference database and will be specifically considered during the specification (WP1) and design (WP2) project activities.

Table 1 - Use case 1 - Almond

Data Source name: Use case mycotoxin detection	
Data source description	
Mycotoxin detection in grounded almonds. Datasets are collected with the 1st and the 2nd prototype. More details in D3.6.	
Dataset entities	Samples used in use-cases 1, 2 and 3 for spectral data base building (WP3) and validation (WP6)
Dataset attributes	See figure above and appendix 1.
Data type	JSON document in the reference dataset. Individual measurements can be downloaded in Excel files.
Standard	NA
Direct data URI	https://dashboard.phasmafood.eu/dashboard/dashboard-menu

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

Data Size	~170KB per measurement without camera image when downloaded as Excel file. ~4MB per measurement with camera image – cloud DB storage format.
Sample size	For v1 prototype: 215 measurements, total of 79.1MB For v2 prototype: 254 measurements, total of 92MB Excluding camera images.
Data lifetime	No expiration
Availability	Publicly available
Data collection frequency	On demand
Data quality	1st prototype – medium quality, 2nd prototype – high quality.
Raw data sample	
For the 1st prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21836/view For the 2nd prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21837/view	
Print screen (if possible)	
For the 1st prototype:  For the 2nd prototype:	

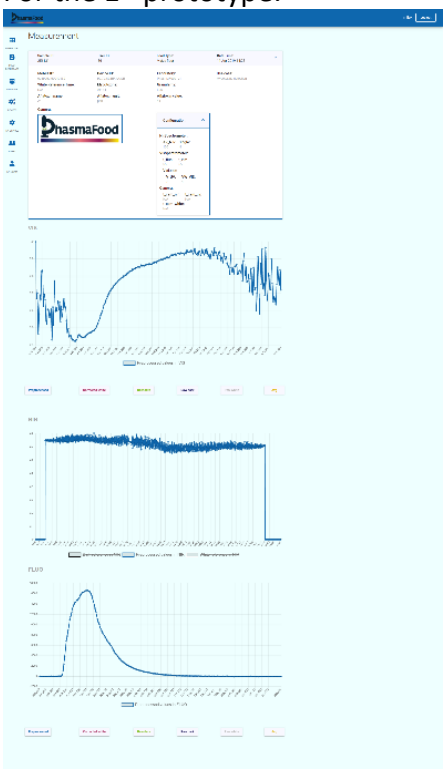


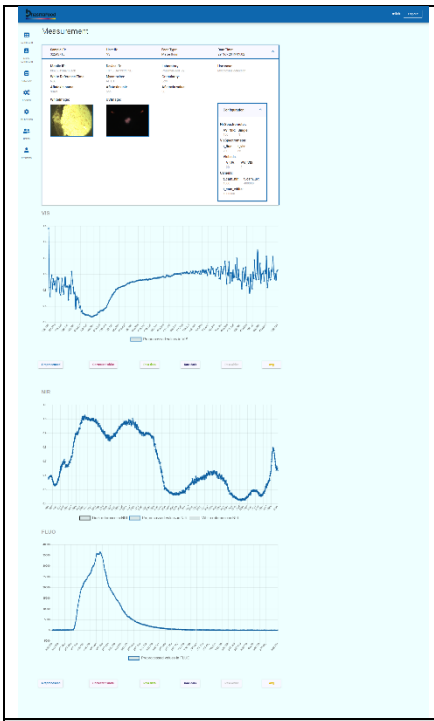
Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.) – Check Appendix 1 and D3.6.

Table 2 - Use case 1 - Maize Flour

Data Source name: Use case mycotoxin detection in maize flour	
Data source description	
Mycotoxin detection in maize flour. Datasets are collected with the 1st and the 2nd prototype. More details regarding the samples, mycotoxin levels and sample preparation is provided in D3.6.	
Dataset entities	Samples used in use-cases 1, 2 and 3 for spectral data base building (WP3) and validation (WP6)
Dataset attributes	See figure above and appendix 1.
Data type	JSON document in the reference dataset. Individual measurements can be downloaded in Excel files.
Standard	NA
Direct data URI	https://dashboard.phasmafood.eu/dashboard/dashboard-menu
Data Size	~170KB per measurement without camera image when downloaded as Excel file.

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

	~4MB per measurement with camera image – cloud DB storage format.
Sample size	For v1 prototype: 34 measurements, total of 12.5MB For v2 prototype: 56 measurements, total of 20.3MB Excluding camera images.
Data lifetime	No expiration
Availability	Publicly available
Data collection frequency	On demand
Data quality	1st prototype – medium quality, 2nd prototype – high quality.
Raw data sample	
For the 1st prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21840/view For the 2nd prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21841/view	
Print screen (if possible)	
For the 1st prototype:  For the 2nd prototype:	

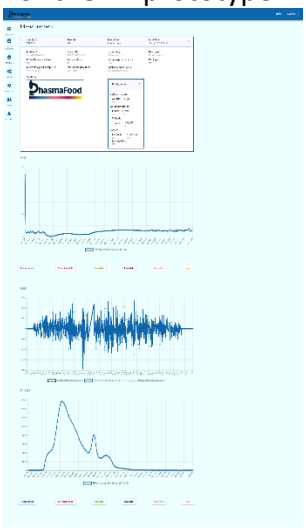
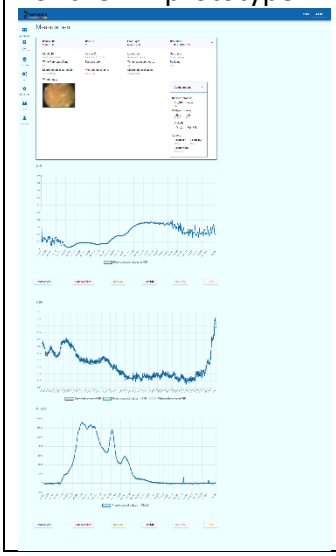


Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.) – Check Appendix 1 and D3.6.

Table 3 - Food spoilage - Minced Pork

Data Source name: Use case food spoilage in minced pork	
Data source description	
Food spoilage and shelf life estimation for minced pork. Datasets are collected with the 1st and the 2nd prototype. More details regarding the samples and sample preparation (temperature and exposure time) is provided in D3.6.	
Dataset entities	Samples used in use-cases 1, 2 and 3 for spectral data base building (WP3) and validation (WP6)
Dataset attributes	See figure above and appendix 1.
Data type	JSON document in the reference dataset. Individual measurements can be downloaded in Excel files.
Standard	NA
Direct data URI	https://dashboard.phasmafood.eu/dashboard/dashboard-menu
Data Size	~170KB per measurement without camera image when downloaded as Excel file. ~4MB per measurement with camera image – cloud DB storage format.
Sample size	For v1 prototype: 111 measurements, total of 41.1MB

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

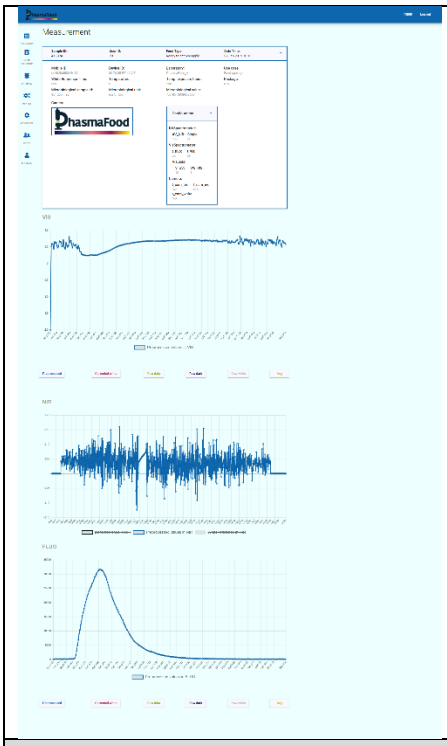
	For v2 prototype: 256 measurements, total of 94MB Excluding camera images.
Data lifetime	No expiration
Availability	Publicly available
Data collection frequency	On demand
Data quality	1st prototype – medium quality, 2nd prototype – high quality.
Raw data sample	
For the 1st prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21844/view For the 2nd prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21845/view	
Print screen (if possible)	
For the 1st prototype:  For the 2nd prototype: 	

Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.) – Check Appendix 1 and D3.6.

Table 4 - Food spoilage - Ready to Eat Pineapple

Data Source name: Use case food spoilage in ready to eat pineapple	
Data source description	
Food spoilage and shelf life estimation for ready to eat pineapple. Datasets are collected with the 1st prototype. More details regarding the samples and sample preparation (temperature and exposure time) is provided in D3.6.	
Dataset entities	Samples used in use-cases 1, 2 and 3 for spectral data base building (WP3) and validation (WP6)
Dataset attributes	See figure above and appendix 1.
Data type	JSON document in the reference dataset. Individual measurements can be downloaded in Excel files.
Standard	NA
Direct data URI	https://dashboard.phasmafood.eu/dashboard/dashboard-menu
Data Size	~170KB per measurement without camera image when downloaded as Excel file. ~4MB per measurement with camera image – cloud DB storage format.
Sample size	For v1 prototype: 139 measurements, total of 51.1MB
Data lifetime	No expiration
Availability	Publicly available
Data collection frequency	On demand
Data quality	1st prototype – medium quality
Raw data sample	
For the 1st prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21848/view	
Print screen (if possible)	
For the 1st prototype:	

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.



Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.) – Check Appendix 1 and D3.6.

Table 5 - Food spoilage - Ready to Eat Rocket Salad

Data Source name: Use case food spoilage in ready to eat pineapple	
Data source description	
Food spoilage and shelf life estimation for ready to eat rocket salad. Datasets are collected with the 1st prototype. More details regarding the samples and sample preparation (temperature and exposure time) is provided in D3.6.	
Dataset entities	Samples used in use-cases 1, 2 and 3 for spectral data base building (WP3) and validation (WP6)
Dataset attributes	See figure above and appendix 1.
Data type	JSON document in the reference dataset. Individual measurements can be downloaded in Excel files.
Standard	NA
Direct data URI	https://dashboard.phasmafood.eu/dashboard/dashboard-menu
Data Size	~170KB per measurement without camera image when downloaded as Excel file. ~4MB per measurement with camera image – cloud DB storage format.

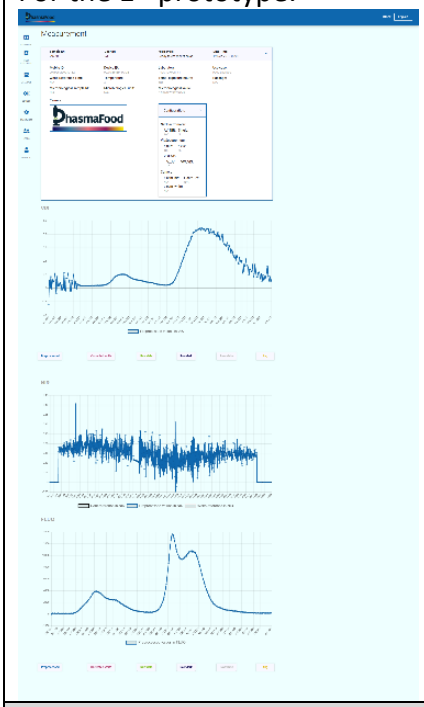
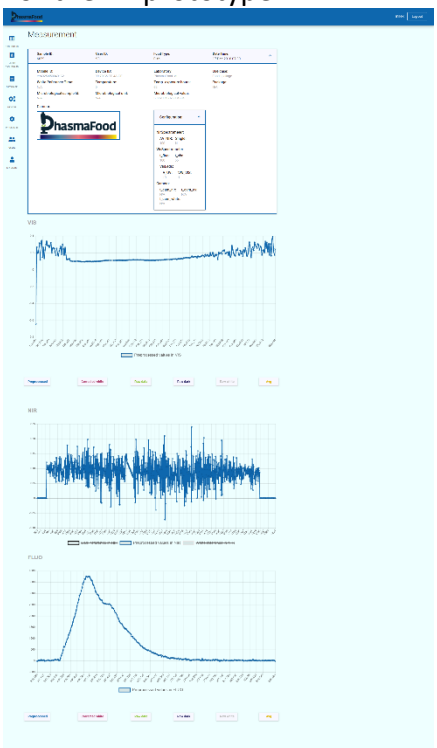
Sample size	For v1 prototype: 91 measurements, total of 33.3MB
Data lifetime	No expiration
Availability	Publicly available
Data collection frequency	On demand
Data quality	1st prototype – medium quality
Raw data sample	
For the 1st prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21850/view	
Print screen (if possible)	
For the 1st prototype: 	
Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.) – Check Appendix 1 and D3.6.	

Table 6 - Food spoilage - Fish

Data Source name: Use case food spoilage in fish	
Data source description	
Food spoilage and shelf life estimation for fish. Datasets are collected with the 1st prototype. More details regarding the samples and sample preparation (temperature and exposure time) is provided in D3.6.	
Dataset entities	Samples used in use-cases 1, 2 and 3 for spectral data base building (WP3) and validation (WP6)
Dataset attributes	See figure above and appendix 1.

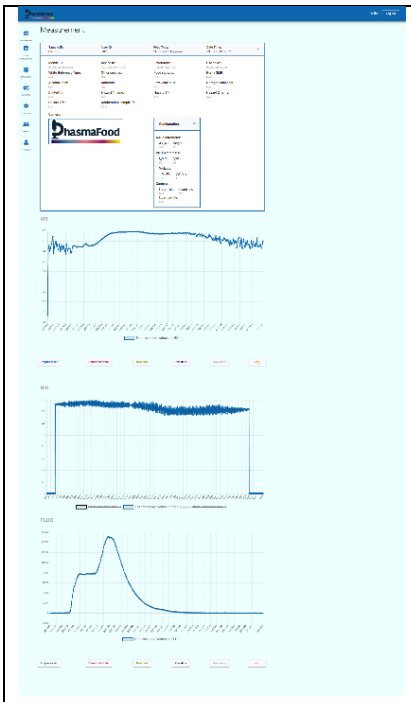
Data type	JSON document in the reference dataset. Individual measurements can be downloaded in Excel files.
Standard	NA
Direct data URI	https://dashboard.phasmafood.eu/dashboard/dashboard-menu
Data Size	~170KB per measurement without camera image when downloaded as Excel file. ~4MB per measurement with camera image – cloud DB storage format.
Sample size	For v1 prototype: 87 measurements, total of 31.9MB
Data lifetime	No expiration
Availability	Publicly available
Data collection frequency	On demand
Data quality	1st prototype – medium quality
Raw data sample	
For the 1st prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21852/view	
Print screen (if possible)	
For the 1st prototype: 	
Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.) – Check Appendix 1 and D3.6.	

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

Table 7 - Food adulteration - Skimmed Milk Powder

Data Source name: Use case food adulteration in skimmed milk powder	
Data source description	
Detection of food adulterants and authenticity in skimmed milk powder. Datasets are collected with the 1st and the 2nd prototype. More details regarding the samples and sample preparation (temperature and exposure time) is provided in D3.6.	
Dataset entities	Samples used in use-cases 1, 2 and 3 for spectral data base building (WP3) and validation (WP6)
Dataset attributes	See figure above and appendix 1.
Data type	JSON document in the reference dataset. Individual measurements can be downloaded in Excel files.
Standard	NA
Direct data URI	https://dashboard.phasmafood.eu/dashboard/dashboard-menu
Data Size	~170KB per measurement without camera image when downloaded as Excel file. ~4MB per measurement with camera image – cloud DB storage format.
Sample size	For v1 prototype: 1941 measurements, total of 714.7MB For v2 prototype: 123 measurements, total of 44.3MB Excluding camera images.
Data lifetime	No expiration
Availability	Publicly available
Data collection frequency	On demand
Data quality	1st prototype – medium quality, 2nd prototype – high quality.
Raw data sample	
For the 1st prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21854/view For the 2nd prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21855/view	
Print screen (if possible)	
For the 1st prototype:	

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.



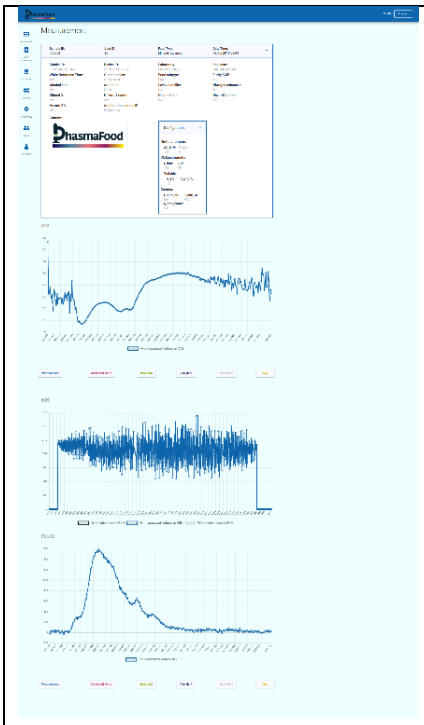
For the 2nd prototype:

Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.) – Check Appendix 1 and D3.6.

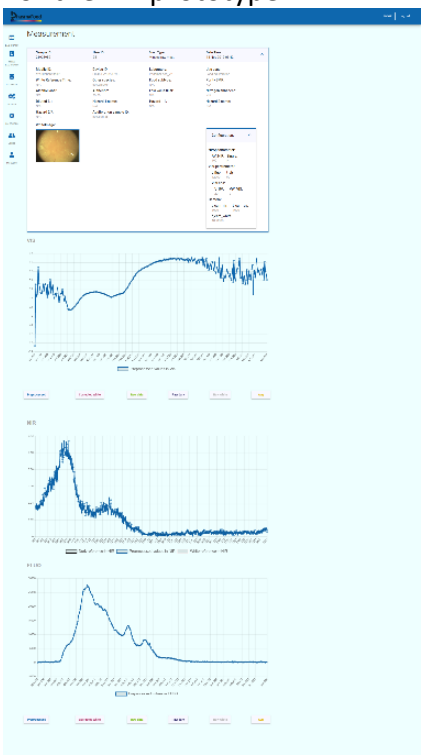
Table 8 - Food adulteration - Minced raw meat

Data Source name: Use case food adulteration in minced raw meat	
Data source description	
Detection of food adulterants and authenticity in minced raw meat (combination of pork and chicken). Datasets are collected with the 1st and the 2nd prototype. More details regarding the samples and sample preparation (temperature and exposure time) is provided in D3.6.	
Dataset entities	Samples used in use-cases 1, 2 and 3 for spectral data base building (WP3) and validation (WP6)
Dataset attributes	See figure above and appendix 1.
Data type	JSON document in the reference dataset. Individual measurements can be downloaded in Excel files.
Standard	NA
Direct data URI	https://dashboard.phasmafood.eu/dashboard/dashboard-menu
Data Size	~170KB per measurement without camera image when downloaded as Excel file. ~4MB per measurement with camera image – cloud DB storage format.
Sample size	For v1 prototype: 119 measurements, total of 43.7MB For v2 prototype: 40 measurements, total of 14.8MB Excluding camera images.
Data lifetime	No expiration
Availability	Publicly available
Data collection frequency	On demand
Data quality	1st prototype – medium quality, 2nd prototype – high quality.
Raw data sample	
For the 1st prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21858/view For the 2nd prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21859/view	
Print screen (if possible)	
For the 1st prototype:	

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.



For the 2nd prototype:

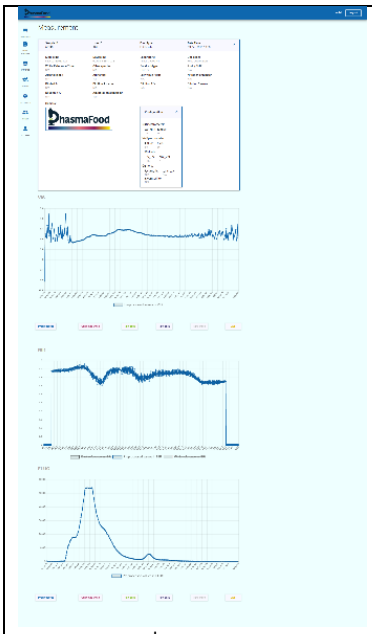


Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.) – Check Appendix 1 and D3.6.

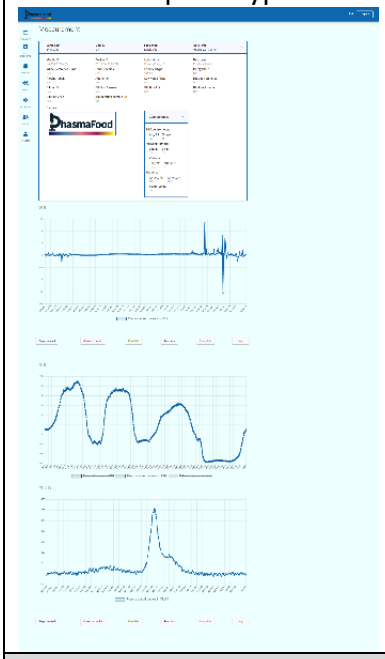
Table 9 - Food adulteration - Edible oils

Data Source name: Use case food adulteration in edible oils	
Data source description	
Detection of food adulterants and authenticity in edible oils. Datasets are collected with the 1st and the 2nd prototype. More details regarding the samples and sample preparation (temperature and exposure time) is provided in D3.6.	
Dataset entities	Samples used in use-cases 1, 2 and 3 for spectral data base building (WP3) and validation (WP6)
Dataset attributes	See figure above and appendix 1.
Data type	JSON document in the reference dataset. Individual measurements can be downloaded in Excel files.
Standard	NA
Direct data URI	https://dashboard.phasmafood.eu/dashboard/dashboard-menu
Data Size	~170KB per measurement without camera image when downloaded as Excel file. ~4MB per measurement with camera image – cloud DB storage format.
Sample size	For v1 prototype: 1215 measurements, total of 447.8MB For v2 prototype: 69 measurements, total of 24.8MB
Data lifetime	No expiration
Availability	Publicly available
Data collection frequency	On demand
Data quality	1st prototype – medium quality, 2nd prototype – high quality.
Raw data sample	
For the 1st prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21862/view For the 2nd prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21863/view	
Print screen (if possible)	
For the 1st prototype:	

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.



For the 2nd prototype:

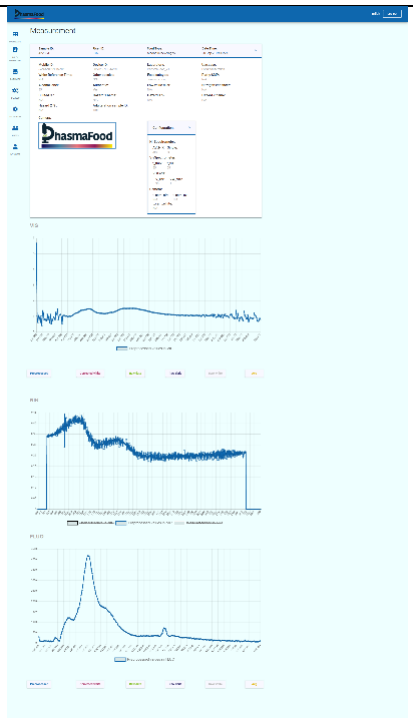


Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.) – Check Appendix 1 and D3.6.

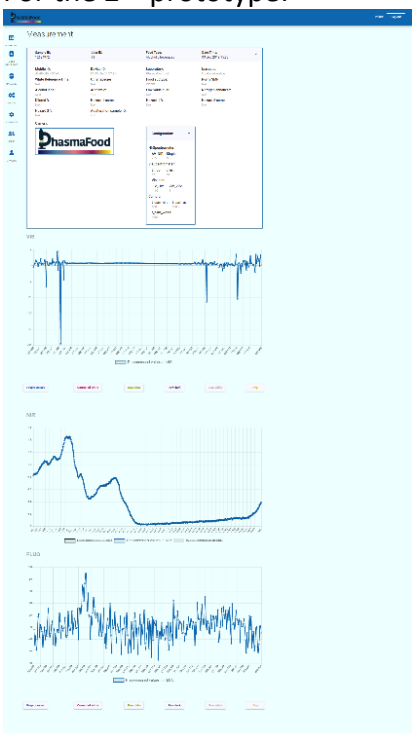
Table 10 - Food adulteration - Alcoholic beverages

Data Source name: Use case food adulteration in alcoholic beverages
Data source description
Detection of food adulterants and authenticity in alcoholic beverages (different kinds of spirits). Datasets are collected with the 1st and the 2nd prototype. More details regarding the samples and sample preparation (temperature and exposure time) is provided in D3.6.

Dataset entities	Samples used in use-cases 1, 2 and 3 for spectral data base building (WP3) and validation (WP6)
Dataset attributes	See figure above and appendix 1.
Data type	JSON document in the reference dataset. Individual measurements can be downloaded in Excel files.
Standard	NA
Direct data URI	https://dashboard.phasmafood.eu/dashboard/dashboard-menu
Data Size	~170KB per measurement without camera image when downloaded as Excel file. ~4MB per measurement with camera image – cloud DB storage format.
Sample size	For v1 prototype: 2032 measurements, total of 746.7MB For v2 prototype: 64 measurements, total of 23MB Excluding camera images.
Data lifetime	No expiration
Availability	Publicly available
Data collection frequency	On demand
Data quality	1st prototype – medium quality, 2nd prototype – high quality.
Raw data sample	
For the 1st prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21866/view For the 2nd prototype: http://rid-redmine.intrasoft-intl.com/dmsf/files/21867/view	
Print screen (if possible)	
For the 1st prototype:	

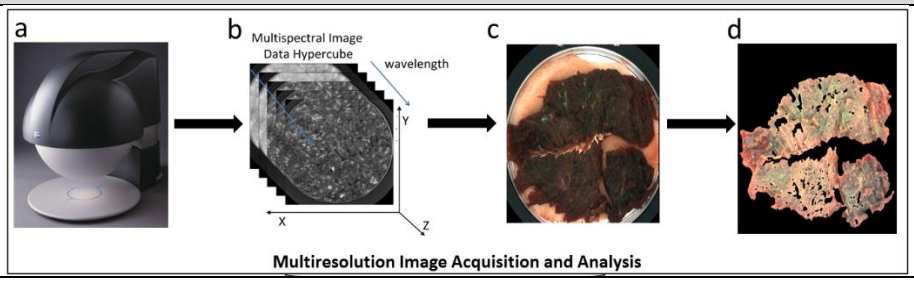


For the 2nd prototype:



Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.) – Check Appendix 1 and D3.6.

3.2 Beef meat spoilage experiment with MultiSpectral Imaging (MSI)

Data Source name: Beef meat spoilage experiment with MultiSpectral Imaging (MSI)	
Data source description	
Beef meat spoilage using Multispectral imaging. Aerobic storage at 2, 8 and 15 °C, sterile and naturally contaminated samples. Prediction and mapping of the microbial load on the surface of meat samples directly from Multispectral Imaging data.	
Dataset entities	Beef meat spoilage.
Dataset attributes	Multispectral images. Each sample consists of 18 images captured at 18 different wavelengths.
Data type	*.hips files. Graphic classification file.
Standard	Hips
Direct data URI	N/A
Data Size	(105 for sterile + 114 for naturally contaminated) x 100MB ~= 22 GB
Sample size	~100MB for each sample
Data lifetime	Overall period of 350 h
Availability	Upon Request due to the large size
Data collection frequency	Meat samples stored at 2 and 8 °C were analyzed every 24 h, whereas samples stored at 15 °C were analyzed every 6 h.
Data quality	Complete and published: Tsakanikas et al (2016) Exploiting multispectral imaging for non-invasive contamination assessment and mapping of meat samples. Talanta 161, 604. http://www.sciencedirect.com/science/article/pii/S0039914016306889
Print screen (if possible)	
	

3.3 Minced pork spoilage experiment with VIS spectroscopy

Data Source name: Minced pork spoilage experiment with VIS	
Data source description	
Spectral data from VIS reflectance with minced pork meat spoilage during aerobic and modified atmosphere packaging (80% O_2-20% CO_2, MAP) storage of minced pork portions (100-g) at different isothermal (4, 8 and 12°C) and dynamic temperature (periodic temperature changes from 4 to 12°C) conditions. Prediction of the microbial load of minced meat samples directly from VIS spectral data.	
Dataset entities	Pork minced meat spoilage
Dataset attributes	VIS spectral data

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

Data type	Comma Separated values text files: *.csv
Standard	csv
Direct data URI	N/A
Data Size	4 (storage temperatures) x ~9 MB = 36 MB.
Sample size	Average 9 MB for each storage temperature. Each csv file is about 20 KB.
Data lifetime	Overall period of 14 and 15 days during storage under aerobic and MAP conditions, respectively.
Availability	Upon Request
Data collection frequency	Duplicate samples (i.e. minced meat patties) were analyzed at regular time intervals (14-24 h), depending on the applied storage conditions (i.e. temperature and atmosphere). Two independent experiments (i.e. different time instances and different meat batches) were conducted, and a total of 228 and 202 minced pork samples were analyzed during aerobic and MAP storage, respectively.
Data quality	
Raw data sample	
Print screen (if possible)	
Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.)	
JSON reference	

```
"VIS":{ "type":"object", "properties":{

        "wavelengths":{ "type":"array", "items":{
            "type":"float" }},

        "measurements":{ "type":"object", "properties":{

            "trainData":{ "type":"array", "items":{
                "type":"object",  "properties":{

                    "columnData":{ "type":"object", "properties":{

                        "measurements":{ "type":"array", "items":{
                            "type":"array", "items":{
                                "type":"float" }}},

                        "dark":{ "type":"array", "items":{
                            "type":"array", "items":{
                                "type":"float" }}},

                        "ref":{ "type":"array", "items":{
```


Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

```
                        "type":"array", "items":{
                            "type":"float" }}}}},

                "averageData":{ "type":"object", "properties":{

                    "measurements":{ "type":"array", "items":{
                        "type":"float" }},

                    "dark":{ "type":"array", "items":{
                        "type":"float" }},

                    "ref":{ "type":"array", "items":{
                        "type":"float" }}}}}}},

        "testData":{ "type":"array", "items":{
            "type":"object", "properties":{

                "columnData":{ "type":"object", "properties":{

                    "measurements":{ "type":"array", "items":{
                        "type":"array", "items":{
                            "type":"float" }}},

                    "dark":{ "type":"array", "items":{
                        "type":"array", "items":{
                            "type":"float" }}},

                    "ref":{ "type":"array", "items":{
                        "type":"array", "items":{
                            "type":"float" }}}}},

                "averageData":{ "type":"object", "properties":{
                    "measurements":{ "type":"array", "items":{
                        "type":"float" }},

                    "dark":{ "type":"array", "items":{
                        "type":"float" }},

                    "ref":{ "type":"array", "items":{
                        "type":"float" }}}}}},

        "overallAverages":{ "type":"object", "properties":{

            "averageDark":{ "type":"array", "items":{
                "type":"float" }},

            "averageRef":{ "type":"array", "items":{
                "type":"float" }},

            "averageMeasurement":{ "type":"array", "items":{
                "type":"float" }}}},

        "preprocessedValues":{ "type":"array", "items":{
            "type":"float" }}}}}
```


Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

3.4 Rocket spoilage experiment with NIR spectroscopy

Data Source name: Rocket spoilage experiment with NIR	
Data source description	
Spectral data from NIR with ready-to-eat rocket salad stored aerobically (in the original commercial packaging) under isothermal conditions (i.e. 4, 8 and 12°C), as well as at dynamic storage conditions (i.e. periodic temperature changes ranging from 4 to 12). Prediction of the microbial load of rocket salad samples directly from NIR spectral data.	
Dataset entities	Rocket spoilage
Dataset attributes	NIR spectral data
Data type	Comma Separated values text files: *.csv
Standard	csv
Direct data URI	N/A
Data Size	4 (storage temperatures) x ~13.8 MB = 55 MB
Sample size	Average 13.8 MB for each storage temperature. Each csv file is about 28 KB.
Data lifetime	Overall maximum period of approximately 10 days (i.e. 254 h).
Availability	Upon Request
Data collection frequency	Duplicate rocket salad samples were analyzed at regular time intervals (14-24 h), depending on the applied storage conditions (i.e. temperature). Two independent experiments (i.e. different time instances and different rocket salad batches) were conducted, and a total of 232 rocket samples were analyzed.
Data quality	
Raw data sample	
Print screen (if possible)	
Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.)	
JSON reference	

```
"NIR":{ "type":"object", "properties":{

    "wavenumbers":{ "type":"array", "items":{
        "type":"int" }},

    "trainData":{ "type":"array", "items":{
```


Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

```
            "type":"object", "properties":{

                "intensity":{ "type":"array", "items":{
                    "type":"float" }},

                "absorbance":{ "type":"array", "items":{
                    "type":"float" }}}},

        "testData":{ "type":"array", "items":{
            "type":"object", "properties":{

                "intensity":{ "type":"array", "items":{
                    "type":"float" }},

                "absorbance":{ "type":"array", "items":{
                    "type":"float" }}}},

        "averageIntensity":{ "type":"array", "items":{
            "type":"float" }},

        "averageAbsorbance":{ "type":"array", "items":{
            "type":"float" }},

        "whiteReference":{ "type":"array", "items":{
            "type":"float" }},

        "darkIntensity":{ "type":"float" }}}
```

3.5 Pineapple spoilage experiment with FLUO spectroscopy

Data Source name: Pineapple spoilage experiment with FLUO	
Data source description	
Spectral data from fluorescence with ready-to-eat fresh-cut pineapple stored aerobically (in the original commercial packaging) under isothermal conditions (i.e. 4, 8 and 12°C), as well as at dynamic storage conditions (i.e. periodic temperature changes ranging from 4 to 12). Prediction of the microbial load of pineapple samples directly from FLUO spectral data.	
Dataset entities	Pineapple spoilage
Dataset attributes	FLUO spectral data
Data type	Comma Separated values text files: *.csv
Standard	csv
Direct data URI	N/A
Data Size	4 (storage temperatures) x ~17.2 MB = 68.8 MB
Sample size	Average 17.2 MB for each storage temperature. Each csv file is about 12 KB.
Data lifetime	Overall maximum period of approximately 10 days (i.e. 230 h).
Availability	Upon Request
Data collection frequency	Duplicate pineapple samples were analyzed at regular time intervals (14-24 h), depending on the applied storage conditions (i.e. temperature). Three independent experiments (i.e. different time instances and different

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

	pineapple batches) were conducted, and a total of 318 pineapple samples were analyzed.
Data quality	
Raw data sample	
Print screen (if possible)	
Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.)	
JSON reference	

```
    "FLUO":{ "type":"object", "properties":{

        "wavelengths":{ "type":"array", "items":{
            "type":"float" }},

        "measurements":{ "type":"object", "properties":{

            "trainData":{ "type":"array", "items":{
                "type":"object", "properties":{

                    "columnData":{ "type":"object", "properties":{

                        "measurements":{ "type":"array", "items":{
                            "type":"array", "items":{
                                "type":"float" }}},

                        "dark":{ "type":"array", "items":{
                            "type":"array", "items":{
                                "type":"float" }}},

                        "ref":{ "type":"array", "items":{
                            "type":"array", "items":{
                                "type":"float" }}}}},

                    "averageData":{ "type":"object", "properties":{

                        "measurements":{ "type":"array", "items":{
                            "type":"float" }},

                        "dark":{ "type":"array", "items":{
                            "type":"float" }},

                        "ref":{ "type":"array", "items":{
                            "type":"float" }}}}}}},

            "testData":{ "type":"array", "items":{
```


Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

```
                "type":"object", "properties":{

                    "columnData":{ "type":"object", "properties":{

                        "measurements":{ "type":"array", "items":{
                            "type":"array", "items":{
                                "type":"float" }}},

                        "dark":{ "type":"array", "items":{
                            "type":"array", "items":{
                                "type":"float" }}},

                        "ref":{ "type":"array", "items":{
                            "type":"array", "items":{
                                "type":"float" }}}}},

                    "averageData":{ "type":"object", "properties":{

                        "measurements":{ "type":"array", "items":{
                            "type":"float" }},

                        "dark":{ "type":"array", "items":{
                            "type":"float" }},

                        "ref":{ "type":"array", "items":{
                            "type":"float" }}}}}}}},

            "overallAverages":{ "type":"array", "items":{
                "type":"float" }}}}
```

3.6 Adulteration of skimmed milk powders

Data Source name:	
Data source description	
Detection of chemical and bulk adulterants in skimmed milk powder. This initial dataset contains ca. 50 authentic skimmed milk powders (SMP), ca. 25 authentic infant formulas and ca. 20 adulterants. In total there are ca. 230 samples, which are measured in triplicate on three days. Several dry blended mixtures were prepared with SMPs and adulterants in order to determine the LOD of the individual sensors and combined sensors. Sensors used: 1. FLUO data – spectroscopic data 2. VIS data – spectroscopic data 3. NIR data – spectroscopic data Chemical reference data of the SMPs is available (moisture, protein, fat).	
Dataset entities	Feasibility of adulterant detection in SMP
Dataset attributes	FLU & VIS: 3 .csv files per measurement (sample data, dark and ref) NIR: 3 .csv files per measurment (sample data, dark and ref)

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

Data type	csv
Standard	?
Direct data URI	Not available yet
Data Size	Ca 20k /file, total files 17820 (when all dark and refs are stored)
Sample size	Ca. 350 MB (when all dark and refs are stored)
Data lifetime	WP 3 – till M 27
Availability	Only available to consortium
Data collection frequency	Test: Nov-Dec 2017, Real:Jun-Jul 2018 – triplicates on three days
Data quality	Fair

Raw data sample (part)

Wavelength[nm]	Average	1	2	3	4	5	6	7	8	9
320.469	2755.7	1024	1267	5151	5138	1024	5153	1248	1089	5427	1036
323.166	3845.3	195	4096	4240	4099	4318	5347	5277	5328	5329	224
325.861	3491.1	26	111	95	4433	4102	5136	5148	5138	5371	5351
328.553	4043.7	61	32	5125	5122	4178	5232	5138	5213	5188	5148
331.243	3931.6	2	5348	5348	5150	5351	4165	204	5328	4323	4097
333.93	4588.3	130	5360	5346	4243	5306	4291	5248	5354	5354	5251
336.615	4740.9	1054	5264	5277	4178	5338	5280	5153	5282	5309	5274
339.297	5036.5	5120	4109	5203	5482	4099	5213	5382	5191	5123	5443
341.976	5205.8	5276	5331	5318	5298	5344	5314	5339	4227	5347	5264
344.653	4463.3	194	5330	5264	5317	5266	5251	4210	5251	4307	4243
347.327	4455.7	1219	5264	5264	5250	5251	5296	1216	5298	5249	5250
349.998	5249.6	5264	5251	5203	5260	5263	5219	5263	5311	5181	5281
352.666	5096.8	4348	4242	5298	5318	5308	5279	5277	5360	5252	5286
355.331	4601.8	4228	5286	189	5319	5328	5369	5341	4316	5325	5317

Print screen (if possible)

NA

Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.)

Field Name	Field Description	Type of Data
Wavelength	Wavenumer	number
Average	Average of 10 scans	number
1 tru 10	Individual replicates	number

I.e. for sub-use-cases on alcoholic beverages and edible oils, a similar structure will be handled.

3.7 Detection of Aflatoxins in grains (Maize) and nuts (Almonds)

Data Source name:	
Data source description	
Detection of Aflatoxins presence in grained Maize and Almonds. The data sets contain a non-contaminated sample and a number of other samples at different contamination levels. First set: Maize artificially contaminated, contamination levels: 0 ppm, 26.23 ppm, 42.40 ppm, 96, 54 ppm. Granularity: >2 mm, <2mm, <1 mm, < 500 µm and <300 µm. Second set: Almonds artificially contaminated, contamination levels: 0 ppm, 7.93 ppm, 11.40 ppm, 20.01 ppm. Granularity: >2 mm, <2mm, <1 mm, < 500 µm Third set: Almonds aritificially contaminated. Contamination levels: 0 ng/g , 2 ng/g, 4 ng/g, 6 ng/g, 8 ng/g, 10 ng/g, 12 ng/g, 16 ng/g, 40 ng/g, 291 ng/g. 4 samples are available for each contamination Fourth set: Maize Lugo naturally contaminated. Contamination levels: 0.5 ppb, 2.3 ppb, 3.2 ppb, 14.6 ppb, 30.4 ppb, 59.2 ppb. 3 samples are available for each contamination level. Fifth set: maize Copparo naturally contaminated. Contamination levels: 3.9 ppb, 11.8 ppb, 27.1 ppb, 50.8 ppb. 3 samples are available for each contamination level Sensors used: 1. FLUO data – spectroscopic data 2. VIS data – spectroscopic data 3. NIR data – spectroscopic data	
Dataset entities	Feasibility of Aflatoxins detection in grains and nuts
Dataset attributes	FLUO: 3 .csv files per measure (sample data, dark and ref), 5 scans per measure VIS: 3 .csv files per scan (sample data, dark and ref), 10 scans per measure NIR: 3 .csv files per measurment (sample data, dark and ref)
Data type	csv
Standard	?
Direct data URI	Not available yet
Data Size	Ca 20k /file
Sample size	Ca. 350 MB (when all dark and refs are stored)

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

Data lifetime	WP 3 – till M 27
Availability	Only available to consortium
Data collection frequency	Test: M3 and M5, Real:M7, M11 First and Second Data set – triplicates on three days (2 at CNR ISPA and 1 at RIKILT) for FLUO and VIS. One replicate in RIKILT) for NIR Third data set: M16 (CNR ISPA) and M18 (RIKILT). 5 replicates in five days of FLUO and VIS (2 at CNR ISPA and 3 at RIKILT) and 2 replicates in two days for NIR. Fourth set: M16 (CNR ISPA) and M18 (RIKILT). 4 replicates (2 at CNR ISPA and 2 at RIKILT) in four days for FLUO and VIS and 2 replicates in two days for NIR Fifth set : M16 (CNR ISPA) and M18 (RIKILT). 2 replicates (1 at CNR ISPA and 1 at RIKILT) in two days.
Data quality	Fair

Raw data sample (part). T

Fluorescence spectroscopy data

Wavelength[nm], Average, 1 ,2 ,3 ,4, 5
320.469,3823.4,3814,3850,3809,3818,3826
323.166,3658.6,3651,3652,3659,3667,3664
325.861,3737.6,3774,3704,3759,3769,3682
328.553,3945.2,3941,3945,3939,3932,3969
331.243,3622.2,3694,3629,3594,3614,3580
333.930,3690.8,3685,3699,3649,3733,3688
336.615,3842.0,3836,3864,3866,3818,3826
339.297,3592.2,3556,3599,3616,3544,3646
341.976,3848.4,3885,3858,3871,3814,3814
344.653,3677.8,3692,3674,3688,3675,3660
347.327,3676.8,3739,3659,3669,3670,3647
349.998,3862.8,3911,3854,3826,3861,3862
352.666,3761.6,3751,3755,3775,3770,3757
355.331,3804.0,3815,3822,3810,3803,3770
357.994,3713.4,3725,3679,3745,3728,3690
360.653,3614.0,3644,3620,3545,3632,3629

Print screen (if possible)

NA

Field Descriptions (Description of the fields within the data, whenever possible; e.g. JSON keys descriptions, Excel Sheet's column descriptions, etc.)		
Field Name	**Field Description**	**Type of Data**
Wavelength	Wavelength values	number
Average	Average of # scans	number
1 tru #	Individual replicates	number

3.8 Image Data

Data Source name: Image data	
Data source description	
Image data are acquired by the Ximea Camera. The Images are used to identify signs of spoilage in food samples (use case 2), but also to identify specific sample features that will drive the selection of the analysis model, like granularity that can affect the spectral results (different diffraction).	
Dataset entities	Images of analysed food.
Dataset attributes	TIFF,. Exposure times: in the range of ms
Data type	*.tiff files.
Standard	
Direct data URI	N/A
Data Size	Depends on the sets of samples
Sample size	~14 MB for each sample
Data lifetime	N/A
Availability	Only available to consortium
Data collection frequency	Once
Data quality	Fine
Print screen (if possible)	
	

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

4 Standards and Metadata

The food sector is highly characterized by non-centralized sources of dynamic and heterogeneous data which increase the information about, for example, meat quality in a particular region, but typically, decrease the effectiveness of sharing that information across stakeholders. The harmonization and standardization of data structures and data exchange services are fundamental challenges for both the information society as a whole, as well as for Food Security applications.

The main focus of PhasmaFOOD is to provide the required data interoperability and adaptability in a variety of food safety settings. PhasmaFOOD will seek to establish liaisons within the food security value chain, with a particular interest in standardising the use of food related Open Data in the food security sector and standardising the types of food related analytics that can be sought from big data platforms.

4.1 Rapid alert system for food and feed (RASFF)

Commission Regulation (EU) No. 16/2011 specifies the framework for implementing measures for the rapid alert system for food and feed (RASFF). The RASFF notifications are generated from templates that provide guidelines on how different fields in the notifications are used. In the table below we provide a sample example of the RASFF fields that are closely related to the PhasmaFOOD application scenarios. Detailed analysis is provided in the project specification document D1.2 *"Functional and System Specifications"*.

RASFF Fields

RASFF Fields	Explanation
notification classification	Classification of the notification according to the definitions given in Regulation 16/2011 and to the guidance given in SOP 5.
information source	Specific source of the information contained in the notification if this is relevant to the understanding of the content of the notification, e.g. a food control body in a third country or a consumer association.
risk decision	Gives information about the evaluation of the risk: - whether the risk is considered to be serious, not serious or undecided; - motivate: why was the risk evaluated as serious (only to be added when the evaluation as serious risk is not straight forward).
product category	Choose the product category from one of the two lists (alphabetical order) or enter it into the other field if the category is not among the entries of the lists or if there are more than one (for more than one product belonging to different categories).
product name(s) (on label)	Precise product name(s), characterising the product(s), without using any commercial name; often the product name on the label that can be found on the packaging.

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

product CN code	Enter the Common Nomenclature code for the product concerned.
product aspect	Here you should enter important characteristics of the product such as the temperature at which it is kept but also e.g. the kind of packaging, etc.
sampling dates	6 separate fields are provided for a maximum of 6 separate values to be entered
sampling info	Make a reference to a compulsory sampling methodology or inform about the circumstances in which the sample was taken (esp. if the sample was taken from an opened packaging of the product etc.).
sampling place	Place where the samples were taken: use the list box provided or the field other if the place is not among the list entries or to specify the name of the operator.
Analytical method(s)	If a specific analytical method was applied, e.g. one described in legislation or in an EN or international standard, enter it here.
hazards identified	Enter the hazards that were evaluated as non-compliant (according to legislation or risk evaluation) as a result of the analysis or analyses.

RASFF List of values

In RASFF when there is mention of an "open list", it is a list of entities to which new entities could be added. The table below outlines the main lists of values used in RASFF.

RASFF Lists of Values	**Explanation**
notification type	Food, food contact material, feed
notification classification	Alert notification, border rejection notification, information notification for Attention, information notification for follow-up, news
product relation	Additional lots, different variety, ingredient, processed product, raw material
risk decision	Serious, not serious, undecided
impact on	Human health, animal health, environment
unit weight/volume	Closed list of units for weight/volume: g, kg, l, ml
temperature	Ambient, chilled, frozen
hazard	Closed list, see annex with an extracted hazards list from RASFF Access database (where the master data for hazards are kept)
durability date	Best before, sell-by, use-by

4.2 World Health Organization (WHO) FOSCOLLAB

The World Health Organization (WHO), through its Department of Food Safety and Zoonoses (FOS), initiated a project named FOSCOLLAB to improve ways of sharing food safety data and information to support risk assessment and decision-making in food safety. FOSCOLLAB is a platform accessible from internet and displaying together within dashboards various data (quantitative and qualitative) and information (e.g. expert advice) useful for food safety

professionals. FOSCOLLAB allows linkages between databases using four criteria: food name, hazard name, country of origin and year for data generation.

FOSCOLLAB Element	Explanation
Sample collection, prep and analysis	Important context can be added to sampling information by also Reporting the sample size, including units, and the sample's representativeness. Where the user is interested in knowing the prevalence of an analyte, or knowing that an analyte is not present with an estimated level of confidence, information about the representativeness of the sample will be very important. In some cases, this is not necessary, for example, where the user of FOSCOLLAB is only seeking an indication of the presence of an analyte
Country of origin of the sample	Country of origin is necessary in identifying the country where contamination occurred
Why sample was collected	Outbreak investigation, recall verification, compliance, random sampling/surveillance, monitoring, baseline studies…
Action Description	Action taken based on laboratory result; e.g. International Health Regulation (IHR) risk assessment/notification
Instrument name	Analytical instrument used to identify analyte ex: Whole-Genome Sequencing (WGS), platforms, test kits, etc.

4.3 Interoperability

PhasmaFOOD data model can be made interoperable with the above listed standards if there are use cases and stakeholders which require application of specific data standard in their processes. The REST API handler for translating between the PhasmaFOOD data model and corresponding standard data model can be easily implemented.

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

5 Data Access and Sharing

Due to the nature of the data involved, some of the results that will be generated by each project phase will be restricted to authorized users, while other results will be publicly available. As is our commitment, data access and sharing activities will be rigorously implemented in compliance with the privacy and data collection rules and regulations, as they are applied nationally and in the EU, as well as with the H2020 rules. In the case end-user testing will be performed, PhasmaFOOD users would be required to pre-register and consent using the system. Then they will need to authenticate themselves against a user database. If successful, the users will have roles associated with them. These roles will determine the level of access that a user will be given and what they will be permitted to do.

As the raw data included in the data sources will be gathered from the closed and controlled laboratory experiments, collected measurements will be seen as highly commercially-sensitive. Therefore, access to raw data can only take place through the partners involved in the performance of the laboratory measurements. For the models to function correctly, the data will have to be included into the PhasmaFOOD cloud database. The results of the food analytics will be secured and all privacy concerns will be catered during the design phase. In the cases of trend analytics, anonymisation methods will be applied as part of the built-in cloud platform features.

Publications will be released and disseminated through the project dissemination and exploitation channels to make external research and market actors aware of the project as well as appropriate access to the data.

Within the project, our produced conference papers and journal publications will be Green Open Access and stored in an appropriate repository – such as OpenAIRE (European Comission, 2015), Registry of Research Data Repositories (German Research Foundation, 2015) or Zenodo (CERN Data Centre, 2015).

5.1 APIs to 3rd party databases

The consortium did not find any external datasets or databases which can be combined with the reference datasets obtained with the PhasmaFOOD integrated system prototype.

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

6 Database Characteristics

6.1 Structure of the cloud database

The PhasmaFOOD cloud platform hosts the PhasmaFOOD data warehouse, which stores all collected sensory measurements and contextual data coming from sensing devices, mobile application and 3rd party services like regulatory databases. From this main database, the PhasmaFOOD cloud platform procedures derive datasets used for training ML models for decision making required by each project use case and scenario.

In the first PhasmaFOOD system prototype, the measurement procedures and supporting data management functionalities are configured so as to streamline creation of new reference data sets and updating the existing ones. The PhasmaFOOD mobile application (as presented in D4.2) enables end users in project laboratories to configure all aspects of the measurements process, label the data and inspect the obtained measurements once the sensing device reports them back. From there, users can choose to send to measurement to the cloud to be analysed (based on preconfigured DA pipeline for that particular analysis scenario) and stored, or just to be stored in the operational DB for further quality inspection. This later feature ensured more efficient building of the reference datasets.

Figure 3 shows the high-level structure of the PhasmaFOOD cloud database. The database comprises the following entities:

- **Operational DB:** maintains necessary information and settings for the PhasmaFOOD platform to operate, including user data, regulatory data, information about registered devices and their settings, ongoing measurements and classifications and analysis results. This database is based on the PostgreSQL for fast transactional operations in the cloud platform and also this particular relational DB enables storing of JSON objects and their proper parsing as such by the cloud procedures responsible for transferring measurement data between the peration DB and the reference data sets as well as exposing these data through the REST APIs. The main entity groups in the operational DB are:
    - **Users:** stores user related data.
    - **Regulatory data:** contains information from regulatory bodies guiding decision making processes and measurement classification.
    - **Sensing Devices:** stores data related to PhasmaFOOD devices.
    - **Measurements and results:** maintains measurements taken from users of the system, settings related to the device used and its configuration and analysis results while allowing the definition of new datasets. It is important to note that this part of the operational DB is used as a quality control stage for newly collected measurements. Users collecting these measurements can inspect them through charts on the PhasmaFOOD web dashboard and decide if they are of sufficient quality to be included into the corresponding reference data sets in the data

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

warehouse. At this stage, users can select through the web dashboard interface one or more measurements and download them in Excel table form. From there, they can use software tools for analysis and comparison which they usually apply as part of their measurement protocols. Finally, users can choose to discard specific measurements which do not pass the quality check phase. This part of the operational DB also stores data analysis results based on DA pipeline applied to the provided measurement. Storing these results enable end users to access their measurement and food analysis history when needed. It is also important for building proactive decision-making techniques for monitoring and predicting food safety (feature enabled, but not explored in the PhasmaFOOD project).

- **Data warehouse:** the focal point for all measurement and contextual data. It stores all collected measurements which have passed the quality check. From here the cloud platform procedures build use case specific reference data sets. This DB is based on the MongoDB which ensure flexibility in document storing so that the reference data model can be updated with new parameters and new use cases and analysis scenarios can be implemented by 3rd parties on top of the PhasmaFOOD system. The main components of this DB are:
    - **Reference data sets:** derived from the data warehouse for each use case and scenario that require specific data fusion and ML model training procedure. It is the working database for training and testing ML models and making reactive decisions based on the current measurement provided by the end user.
    - **Stored DA pipelines and ML models:** this database stores necessary references to stored Data analysis pipelines (see D4.2 for details) and trained ML models so that they can be easily employed by SW behind decision making processes. Each trained DA pipeline and estimator are accompanied with cross-reference results and performance metrics. This enables comparison between the active pipelines and newly configured and trained ones. This comparison is feature of the PhasmaFOOD ML playground (see D4.2 for details).
    - **Online repository for collected images:** this part of the cloud DB stores images coming from integrated CMOS camera.
- **Archive:** stores analysis results and history of conducted measurements. It is used for offline data analysis and safe keeping the data warehouse state in case of data corruption. Periodic backups of the data warehouse and operational DB ensure that all key information and latest reference datasets are properly secured in case of platform malfunction.

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

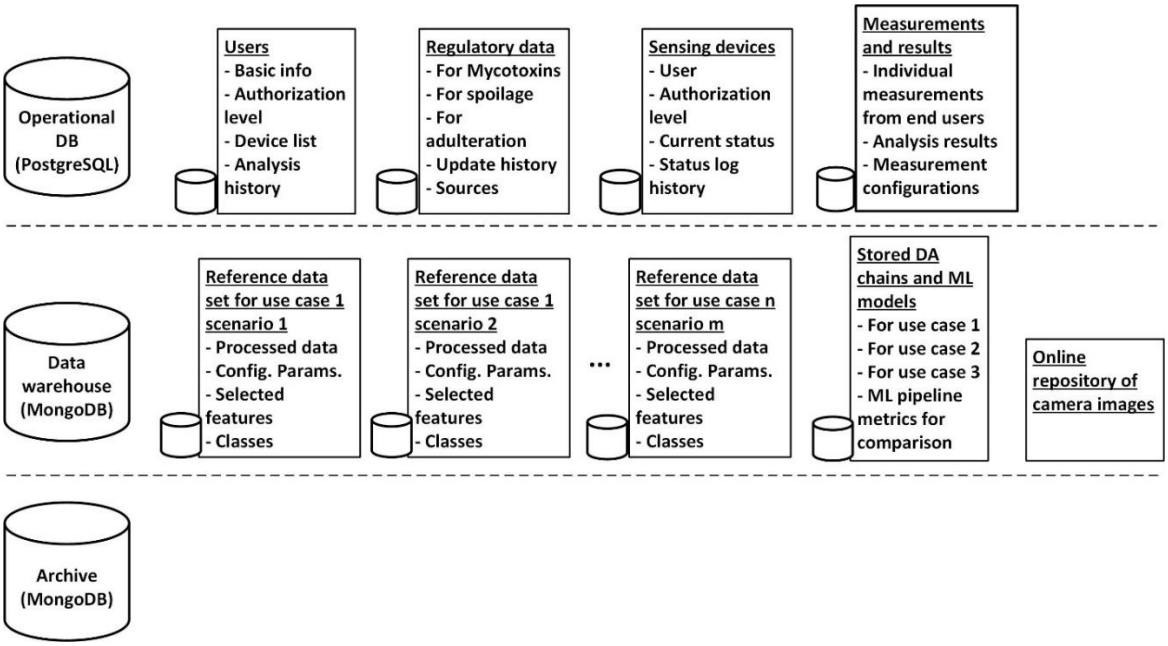


Figure 2 - PhasmaFOOD cloud DB

7 Data Management Plan Checklist, Archiving and Preservation

7.1 Archiving and Preservation

All original raw data files and data source processing programs are under versioning and are maintained in a date-stamped file structure with text files documenting the background and introduced changes between versions (Changelogs). The data is maintained in the PhasmaFOOD cloud repositories, replicated in more than one location and are automatically backed up based on a standardized schedule. These backups can be brought back online within a reasonable timeframe that ensures that there is no detrimental effect of the data being lost or corrupted. As a matter of fact, the whole PhasmaFOOD database is backed up prior to introducing a new dataset and after the dataset introduction in an attempt to maintain several checkpoints that allow fast restoration of the whole database. Furthermore, the batch upload processes can re-create the whole database from the raw data if a need arises.
Daily cloud platform instance archiving (including the whole database) is implemented. The cloud platform stores daily snapshots for two weeks and then starts overwriting the snapshots with new ones.

7.2 Data Management Plan Checklist

At the end of the project, the following checklist will ensure that the criteria in successfully implementing an Open Access Data Management Plan are met. By adhering to the items below, the project will provide open access to the appropriate data and software, and thereby, enable researchers to utilize the findings of this project to further expand their knowledge capacity and personal gains as well as to provide the ITS industry with the necessary tools to advance their business and processes.

1 Discoverable:
    a. Are the relevant data that are to be made available, our project publications or any Open software that has been produced or used in the project, easily discoverable and readily located?
    b. Have we identified these by means of a standard identification mechanism?
2. Accessible:
    a. Are the data and associated software in the project accessible, where appropriate, and what are the modes of access, scope for usage of this data and what are the licensing frameworks, if any, associated with this access (e.g. licensing framework for research and education, embargo periods, commercial exploitation, etc.)?
3. Useable beyond the original purpose for which it was collected:
    a. Are the data and associated software, which are made available, useable by third parties even after the collection of the data?

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

b. Are the data safely stored in certified repositories for long term preservation and curation?
c. Are the data stored along with the minimum software, metadata and documentation to make them useful?

4. Interoperable to specific quality standards:
    a. Are the data and associated software interoperable, allowing data exchange between researchers, institutions, organizations, countries, etc. (e.g. adhering to standards for data annotation, data exchange, compliant with available software applications, and allowing re-combinations with different datasets from different origins)?

8 Conclusions

This deliverable provided an overview and update of the adopted approach regarding data collection and sharing during the course of the PhasmaFOOD project and after its end. This version describes the overall framework and serve as the final document of the PhasmaFOOD project.

In this version of the deliverable, the descriptions of the Use Case related Datasets collected until the end of the project have been provided. Standardization and interoperability aspects have been presented as well as storing, sharing and access procedures of the project data. In this current version the document has also highlighted the procedures established during the organization and subsequent upload of the laboratory measurements in the PhasmaFOOD reference database.

In this version we have also focused -among other- on a final presentation of the total of the different laboratory experiments organized during the project, data collection, description of the PhasmaFOOD database characteristics, update of data access and sharing and update of data interoperability priorities. Data regarding hardware design and specification as well as software design and implementation (cloud, mobile and embedded level) have been also addressed.

9 References

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10 Annex

10.1 Data Model (JSON Schema Format)

Sample:{

--general information ----

"sampleID":{ "type":"string" },

"laboratory":{ "type":"string" },

"userID":{ "type":"string" },

"deviceID":{ "type":"string" },

“useCase”: { "type":"string" }, {Mycotoxins detection, Food spoilage, Food adulteration, }

“foodType”: { "type":"string" }, {Meat, Fish, Fruits and vegetables, }

“foodSubtype”: { "type":"string" }, {olive oil or sunflower oil, meat species, spirits/wine/beer}

“whiteReferenceTime”: { "type":"string" },

---- use case 1 specific parameters ---

“mycotoxinID”: { "type":"string" },

“granularity”: { "type":"string" },

“mycotoxins”: { "type":"string" },

"alfatoxinName": { "type":"string" },

"alfatoxinValue": { "type":"string" },

"alfatoxinUnit": { "type":"string" },

--- use case 2 specific parameters ----

"microbioSampleId": { "type":"string" },

“temperature” : { "type":"string" },

"tempExposureHours": { "type":"string" },

"microbiologicalUnit": { "type":"string" },

"microbiologicalValue": { "type":"string" },

“package”: { "type":"string" },

--- use case 3 specific parameters ---

"adulterationSampleId": { "type":"string" },

"otherSpecies": { "type":"string" },

"foodSubtype": { "type":"string" },

"alcoholLabel": { "type":"string" },

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

"authentic": { "type":"string" },

"puritySMP": { "type":"string" },

"dilutedPct": { "type":"string" },

"lowValueFiller": { "type":"string" },

"nitrogenEnhancer": { "type":"string" },

"hazardOneName": { "type":"string" }, {these 4 parameters will also be mapped for Dilution sources for oils}

"hazardOnePct": { "type":"string" },

"hazardTwoName": { "type":"string" },

"hazardTwoPct": { "type":"string" },

--- configuration of individual sensors ---

“NirSpectrometer”: {

“single”: { "type":"string" },

“av_NIR”: { "type":"number" },

}

“VisSpectrometer”: {

“t_vis”: { "type":"number" },

“t_fluo”: { "type":"number" },

“visLeds”: {

“Vw_vis”: { "type":"number" },

“V_UV”: { "type":"number" },

}

}

“camera”: {

“capture_image_white”: “YES or NO”,

“capture_image_uv”: “YES or NO”,

“capture_image_nir”: “YES or NO”,

“t_cam_white”:”number”, //exposure time for camera with White leds in us

“t_cam_uv”:”number”, //exposure time for camera with UV leds open in us

“t_cam_nir” ”number” //exposure time for camera with NIR leds open in us

}

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

```
        }
--- measurement data ----
        "FLUO":{ "type":"object", "properties":{
                "preprocessed":{ "type":"array", "items":{
                        "type":"array", "items":{
                                "type":"array", "items":{
                                        "type":"string" }}}},
                "whiteReference":{ "type":"array", "items":{
                        "type":"array", "items":{
                                "type":"array", "items":{
                                        "type":"string" }}}},
                "darkReference":{ "type":"array", "items":{
                        "type":"array", "items":{
                                "type":"array", "items":{
                                        "type":"string" }}}},
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        }
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