



“Ultra-compact, low-cost plasmo-photonic bimodal multiplexing sensor platforms as part of a holistic solution for food quality monitoring”

Newsletter N° 2 – March 2023



PHOTONICS PUBLIC PRIVATE PARTNERSHIP

The project is funded by Horizon 2020, the EU Framework Programme for Research and Innovation for 2014-2020 under grant agreement N° 101007448.

The project is an initiative of the Photonics Public Private Partnership

FLEXIBLE FARM-TO-FORK SENSING - Call identifier: H2020-ICT-2020

AIM:

- ✓ Develop an innovative sensor for faster, cost-effective, and reliable monitoring of food quality and safety in the fruit and vegetable value chains. The developed devices will be validated in various production and distribution systems.

OBJECTIVES:

- ✓ Develop a novel ultra-compact, cost-effective, plasmo-photonic bimodal sensor platform with on-chip light generation suitable for *farm-to-fork* applications
- ✓ Develop the GRACED sensing devices to cover different application requirements (reusability, multi-modality, connectivity)
- ✓ Test the novel device for specific identification of chemicals (e.g. Imidacloprid, Acrylamide), toxins (e.g. Ochratoxin A, Aflatoxin B2 and Deoxynivalenol) and foodborne pathogenic bacteria (e.g. *E.coli* O157 and *Salmonella* strains)
- ✓ Develop a data analytics and smart Decision Support System (sDSS) platform to enable photonic-driven applications
- ✓ Validate the complete approach and its impact within the following real-world scenarios:
 - food production by small/medium-sized farms
 - novel types of food production (urban farming)
 - on-site food processing and vending (in-situ restaurants, on-site vending)

EXPECTED OUTCOME:

- ✓ A portable instrument for laboratory & field analysis of all types of samples
- ✓ A novel IoT autonomous sensing module for unattended field measurements of liquid samples used in production systems operating with minimum human intervention (e.g. vertical/urban farming)
- ✓ A new cloud-based platform for descriptive, predictive, and prescriptive data analytics as a smart Decision Support System (sDSS)

Project progress

The GRACED project had a significant progress over the last year (2022) and successfully handled any difficulties without impact to the overall project timeline. The Consortium had the opportunity to meet several times, discuss the issues arising and find the most applicable solutions to allow the smooth progress of the project. The project's up-to-date research and development, involves several iterations and modifications which in turn, led to improved modules.

The thermoelectric module (TCM) has been carefully modified to allow proper connection with the new mechanical (MEC) and fluidic module (MFM) and due to the repurposing, they are now more suitable with the chip. **(Figure 1)**



Fig. 1 GRACED MEC, TCM, MFM

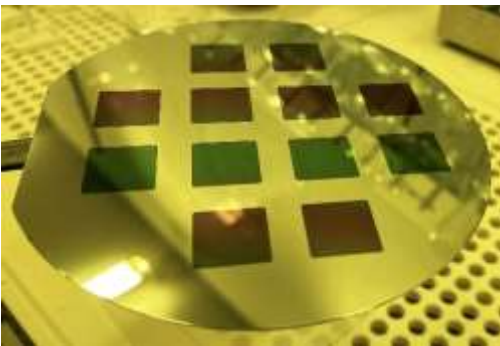


Fig. 2 GRACED sensor wafer

The OSS (optical subsystem) currently has a more robust spatial filtering. This new configuration provides a substantially reduced stray light.

The plasmonic response was observed with the optical subsystem using the FAU (fiber array unit) output configuration which allows improved filtering of stray light **(Figure 3)**.

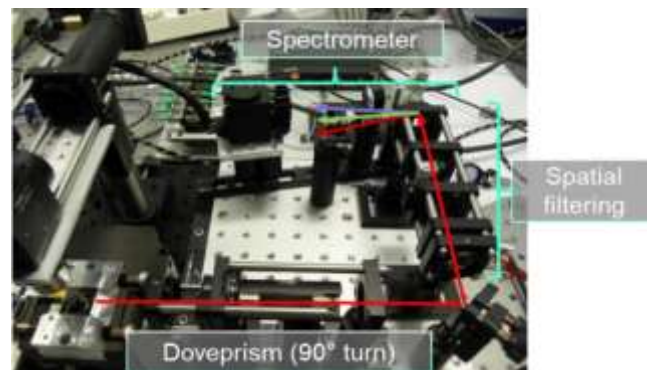


Fig. 3 GRACED OSS

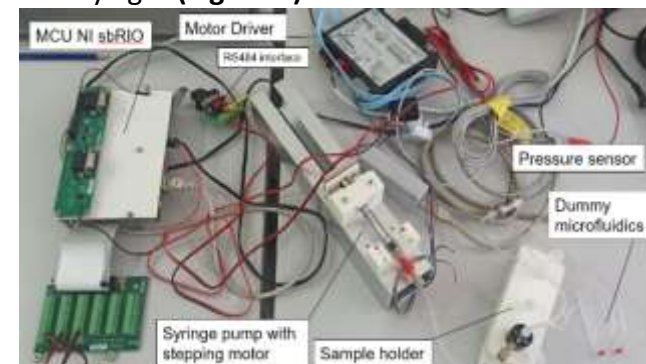


Fig. 4 GRACED Sample Delivery Subsystem

The design of the sample delivery subsystem for the GRACED Instrument is provided in **figure 4** and targets compatibility with the microfluidic module. This design includes a sample delivery subsystem with one-channel microfluidic module and negative-pressure liquid delivery via a syringe.

System integration

✓ *First meeting*

The first GRACED mid-integration meeting was organized by **Multitel** on the 18th -22nd of July 2022 and took place in Mons, Belgium. Consortium members came together to try to make an initial prototype of the GRACED instrument. The meeting was focused on the control and communication between the modules, the integration, testing, and validation of the GRACED instrument and IoT (**Figure 5**).

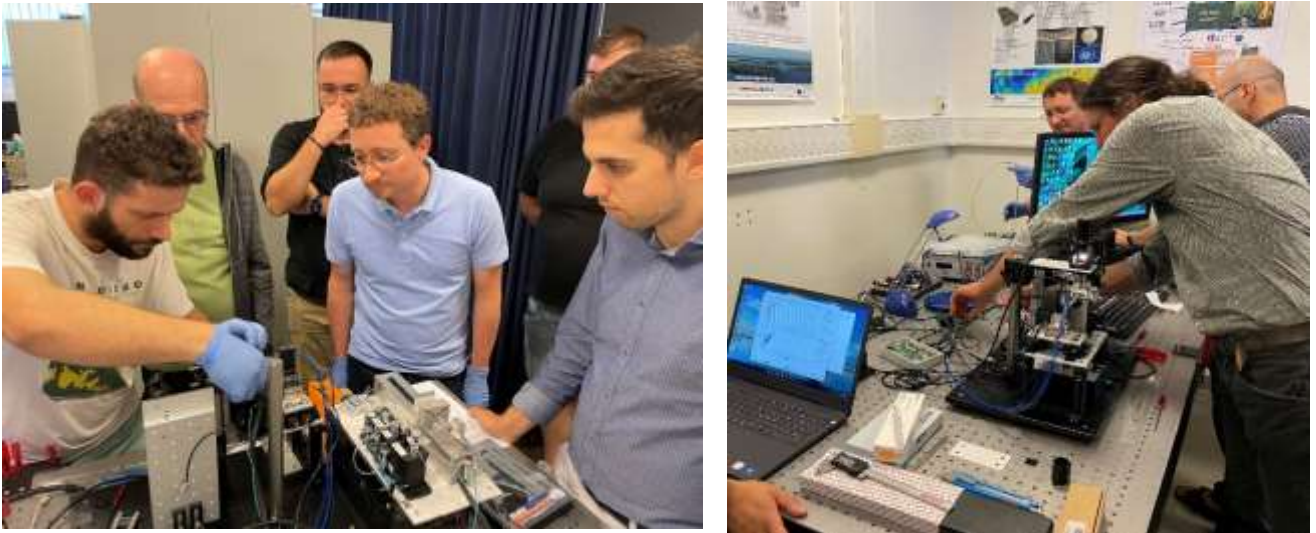


Fig. 5 GRACED 1st mid-project integration

✓ *Second meeting*

The second GRACED mid-integration meeting also took place at **Multitel** in Mons, Belgium on the 10th -14th of October 2022. This focus was on solving previously identified technical issues concerning chips and reference analytes samples (**Figure 6**).

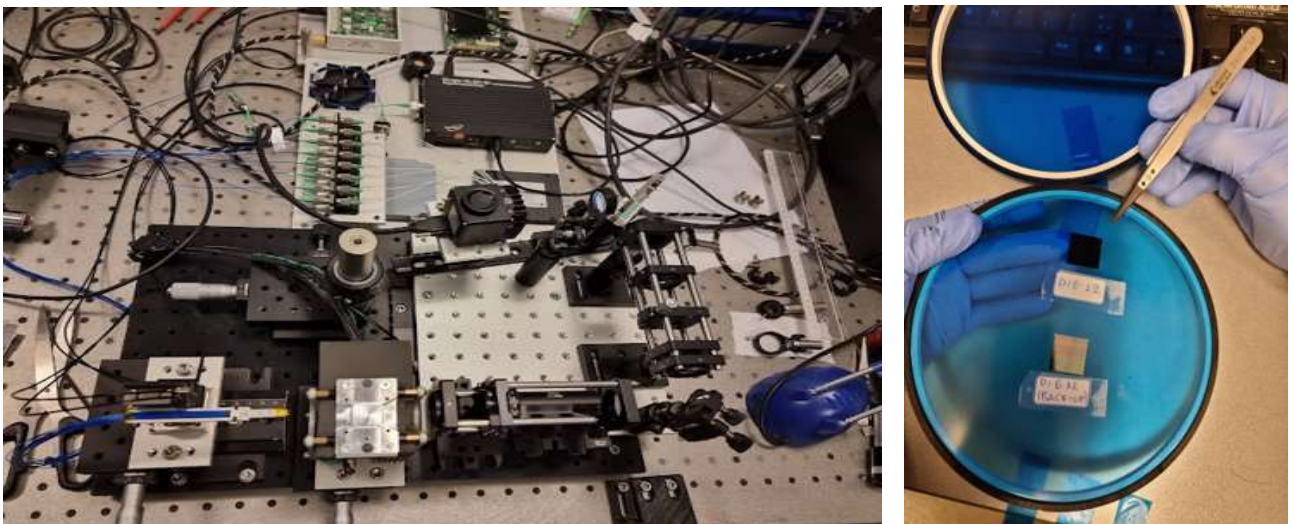


Fig. 6 GRACED 2nd mid- project integration

Consortium Meetings

✓ 18M project meeting

The **GRACED** 18M project meeting was organized by **Sous Les Fraises** in Paris, France on the 22nd -23rd of June 2022. The discussion was mainly focused on upgrades and plans of the various HW and SW modules and preparation for exploitation plans (**Figure 7**).



Fig. 7 GRACED 18M project meeting

✓ Review meeting

The **GRACED** review meeting was organized by **CyRIC** on the 20th of September 2022 and took place remotely. The focus of this meeting was the EC technical review concerning the first project period, relevant report and questions or concerns for proper evaluation of work.

✓ 24M project meeting

The **GRACED** 24M project meeting was organized by **Tecnoalimenti** on the 30th of November – 1st of December 2022 and took place in Milan, Italy. The aim of these discussions was further upgrades and plans of the various HW and SW modules and preparation for exploitation plans. (**Figure 8**)



Fig. 8 GRACED 24M project meeting

✓ Next Consortium meeting:

The next GRACED Consortium Meeting (M30) is scheduled as a physical meeting for the June 2023, and will be hosted by CyRIC in **Cyprus**.

Plans for the next six months:

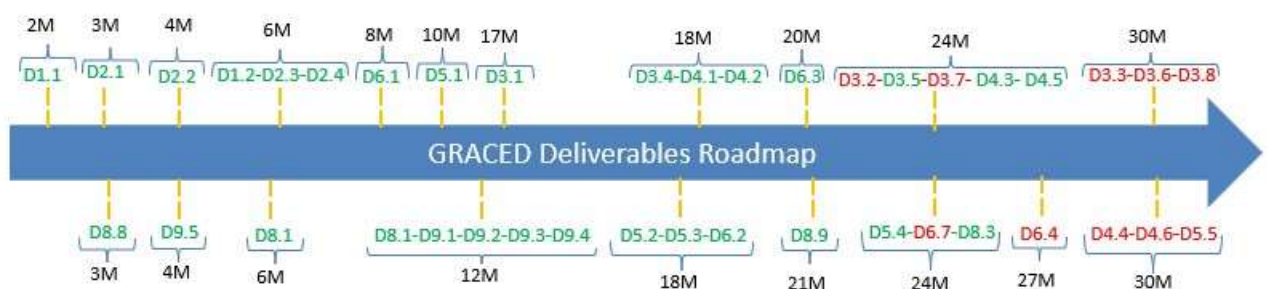


Fig. 9 GRACED Deliverables Roadmap

Dissemination Activities

QUALITY CONTROL

New sensor for quality control

Produce in fruit and vegetables are the source of almost 11,000 deaths each year while contamination by bacteria causes illness for 1 in 10 people¹. Together they cause worldwide problems to nearly 800 million people. Monitoring these inputs from microscopic chemical substances and dangerous microorganisms can take days when samples are sent to laboratories for analysis. Since January 2021, a novel device, which uses photonics for rapid identification of minute traces of toxic components or microorganisms. Two lines under development as a number of locations in Europe.

In May 2020, the European Commission launched the 'Farm to Fork' strategy as part of the European Green Deal aiming to transition to a more sustainable food value chain. Traditional food systems have been proven to be non-sustainable; they are based on the use of large amounts of natural resources, can have negative health impacts on consumers and are often not consistently sustainable for producers. The Farm to Fork strategy aims to apply new technologies and scientific discoveries to food systems as well as to increase public awareness to benefit all stakeholders.

In this context, EU funded project GRACED - "Ultra-compact, low-cost plasma-photonics bimodal multiplexing sensor platform as part of a holistic solution for food quality monitoring" proposes the development of a solution that ensures food quality by detecting contaminants that can be harmful as food when consumed. GRACED is a three and a half year project responding to one of the calls

Marie-Anastasi introduces the EU GRACED project, which is piloting the use of a photonics-based sensor for fruit and vegetable quality control.

under the Photonics Public Private Partnership. The project received a grant of €1,000,000 from Horizon 2020 under the Research and Innovation action funding scheme.

GRACED proposes the delivery of a new alternative detector, which harnesses light particles to spot minute traces of pesticide or bacteria within minutes. The goal is to achieve objective quality control by much more frequent analysis of the safety of fruit and vegetables supplied for consumption. The team will build devices that identify multiple contaminants using a single sensor for three detectors. The sensors developed within the project will be demonstrated against seven contaminants of interest allowing them to be traced simultaneously. Moreover, the time required for contaminant detection will be short, allowing results in less than 30 minutes.

The GRACED vision
The Consortium, a group of fourteen European partners, will develop two versions of the GRACED device: a portable analytical instrument to be used across the value chain and/or an IoT detector of "smart" fields which allows integration of chemistry study within the production line or directly at the farm. The instrument

and IoT devices will allow detection of contaminants without the need to carry out bench-top analysis or sample preparation, which would require traditional laboratory testing. One of the many valuable additions of the GRACED device is the ability to test for the presence of contaminants at all stages of the value chain, which is absent in the project's four pilots.

Furthermore, the team will feature the capabilities of data analysis to make informed and targeted decisions. In addition, the GRACED team will also develop a data storage and analysis platform. The platform will store measurements getting from the sensors connected to it, as well as valuable data coming from other sensors or similar measurements, which an App will also inform the user reading.

The GRACED sensors
The greatest innovation of the project is the development of a plasma-photonics bimodal measurement sensor. These sensors are at the core of the GRACED device allowing identification of contaminants at molecular level and rapid molecular diagnosis. The hardware is combined with low cost no chip light generation, capable of simultaneously and quickly detecting different contaminants of interest. The on-chip light generation also adds to the robustness of the method.

In the presence of a harmful contaminant, a signal is transmitted by detecting the binding of the contaminant to the surface of the sensor. The sensor response will only



✓ **We marked GRACED' two year anniversary with a press release providing a brief on our progress**

DATE: 20/12/2022

GRACED – Two years into the project! Second validation about to start

As consumer demand for fresh fruits and vegetables (F&V) continues to increase, so does the risk of microbiological and chemical contamination. Currently, inspections for F&V are carried out at the production site or the food processing facility, based also on regulatory requirements. In most cases these are inspections of random batches using laboratory techniques, which may require up to two or more days before getting results. The time and cost per analysis leads to reduced checks and thus, elevated risks, even in countries with very efficient control mechanisms.

GRACED (EU funded project, entitled "Ultra-compact, low-cost plasma-photonics bimodal multiplexing sensor platform as part of a holistic solution for food quality monitoring") considers the aforementioned need and the limitations of current techniques and proposes a novel solution for contaminants detection in all stages of the F&V industry value chains.

✓ **GRACED introduced in the Journal of the Institute of Food, Science and Technology**



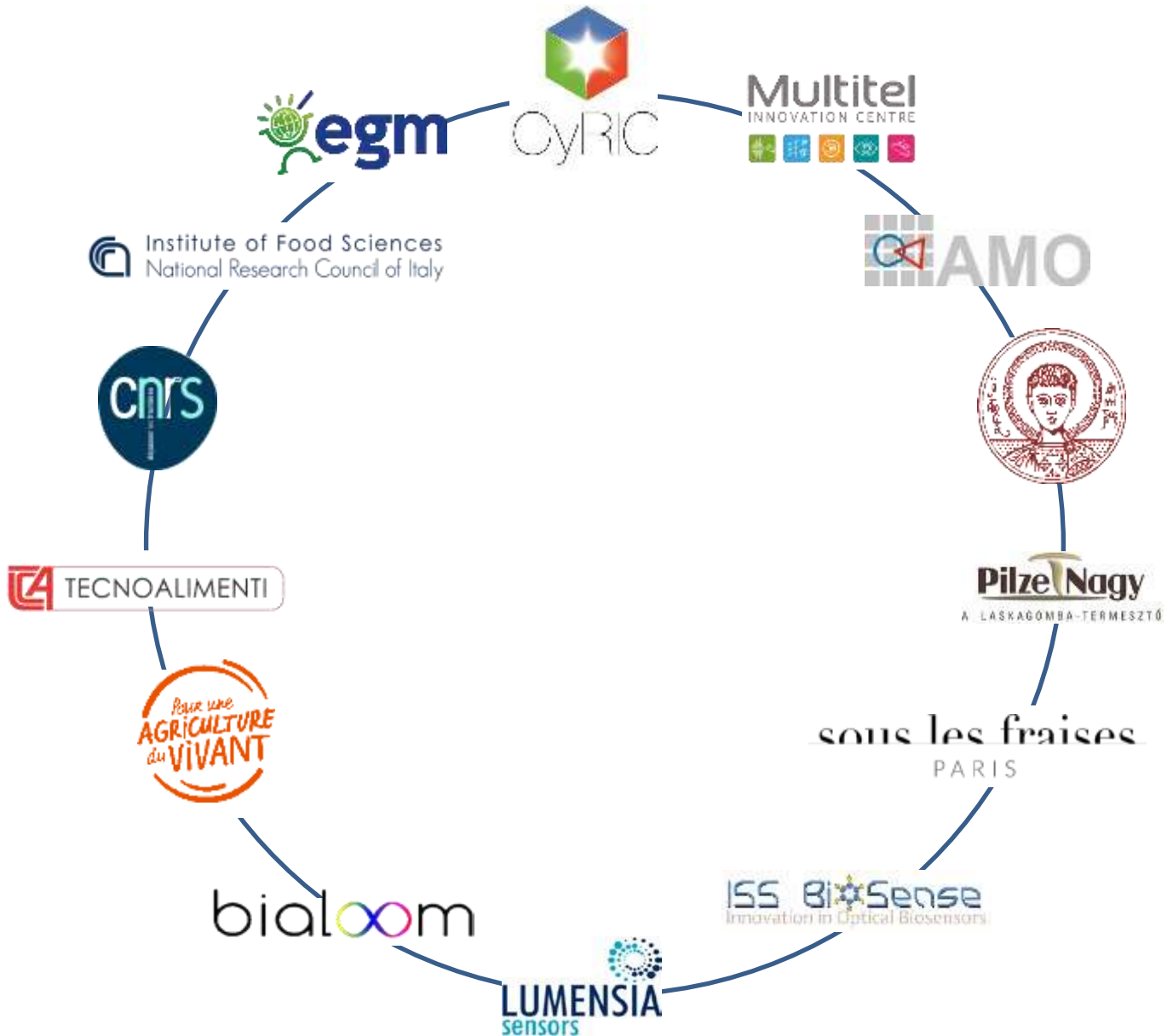
Find all our open-access publications at the [GRACED Zenodo Community](#).

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The Consortium



The logo for "graced" features the word in a lowercase, sans-serif font. A green leaf-like shape is positioned to the left of the 'g', and a blue arrow-like shape is positioned to the right of the 'd'.

A project led by **CyRIC**
www.graced.tech