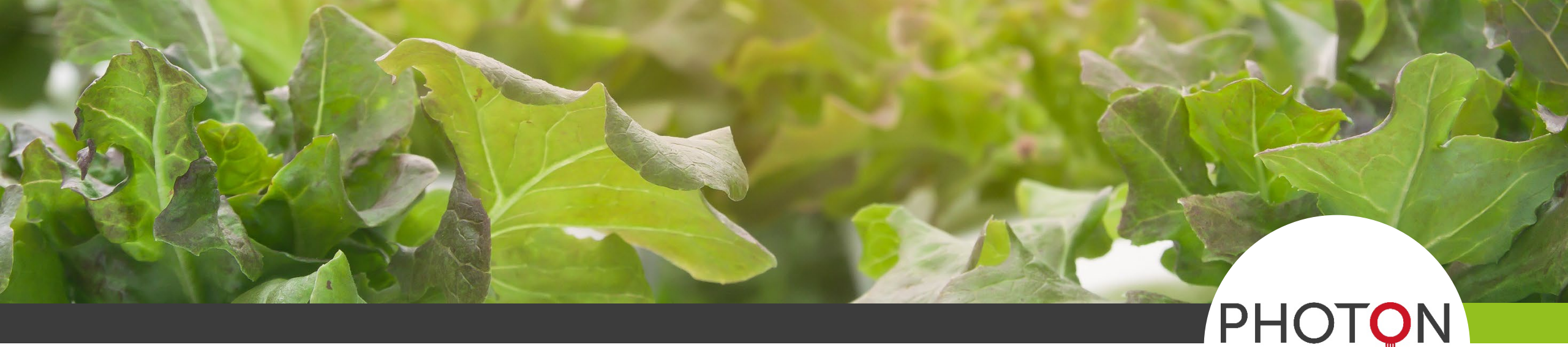


PHOTONFOOD

Flexible mid-infrared photonics solutions for rapid farm-to-fork sensing of food contaminants

Boris Zimmermann, Research Professor

Biospectroscopy and Data Modeling Group
Faculty of Science and Technology
Norwegian University of Life Sciences (NMBU)

Project website
www.photonfood.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101016444.

Photonics Public Private Partnership
www.photonics21.org

PHOTONFOOD in a nutshell

Duration: 01.01.2021 – 31.12.2024

The main objective of the PHOTONFOOD project is to develop and demonstrate in real settings a flexible **mid-infrared photonic devices** for the detection of microbial and chemical contaminations based on **innovative light sources, paper-based sample handling and advanced data mining solutions**.

Handheld device for monitoring
MI-FI

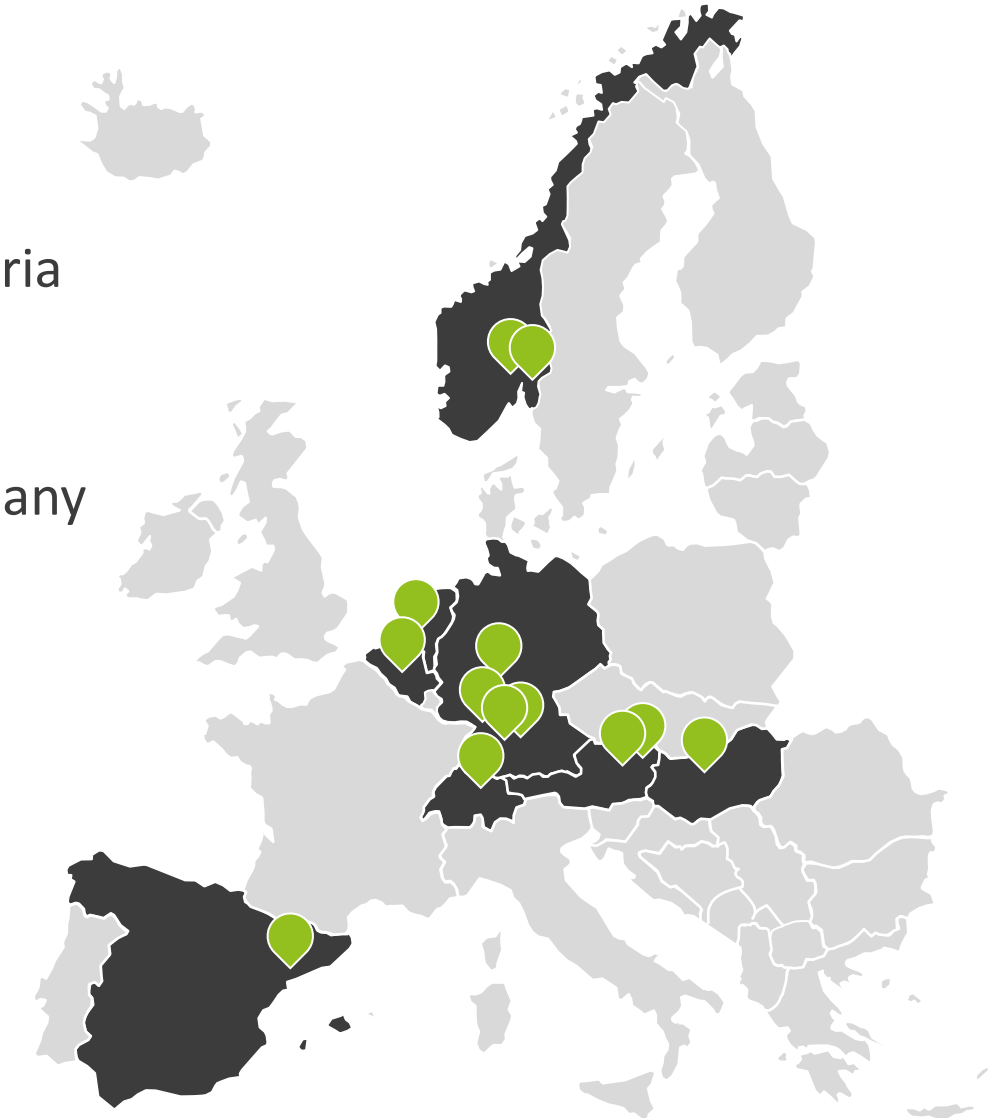
Portable device for reference analysis
HI-FI

The PHOTONFOOD devices are designed for:

- **Detection at critical levels**
- **Rapid, on-site results**
- **Low-cost analysis**

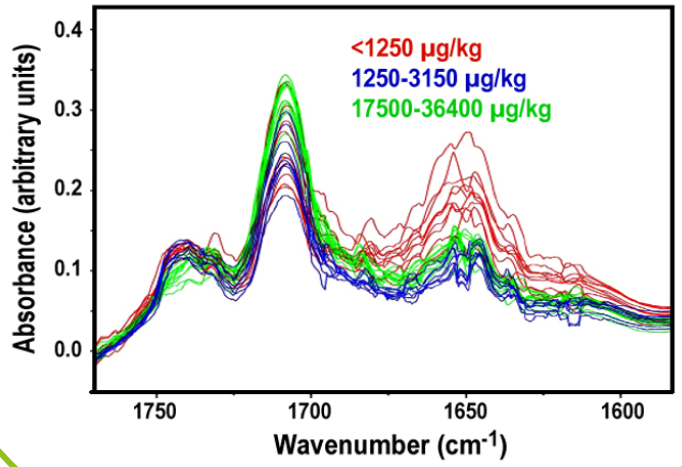
Consortium

- Norwegian University of Life Sciences, Norway
- Ulm University, Germany
- University of Natural Resources and Life Sciences, Austria
- Wageningen University, Netherlands
- Hahn-Schickard, Germany
- nanoplus Nanosystems and Technologies GmbH, Germany
- Romer Labs, Austria
- IRIS Technology Solutions S.L., Spain
- National Food Chain Safety Office, Hungary
- BIGH Anderlecht SPRL, Belgium
- Seeberger GmbH, Germany
- BAMA Gruppen AS, Norway
- accelopment Schweiz AG, Switzerland



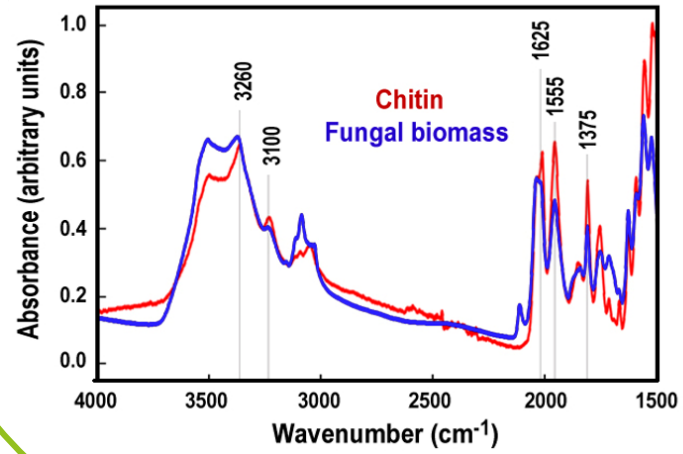
Detection of mycotoxins and fungi by mid-IR spectroscopy has been demonstrated by the consortium before the project start

IR spectra of maize extracts with different deoxynivalenol contamination levels



Portable infrared laser spectroscopy for on-site mycotoxin analysis
Sieger, M., G. Kos, M. Sulyok, M. Godejohann, R. Krska and B. Mizaikoff
J. Scientific Reports 7 (2017) 44028.

IR spectra of chitin and fungal biomass with the characteristic spectral biomarkers for detection of fungal contaminants.

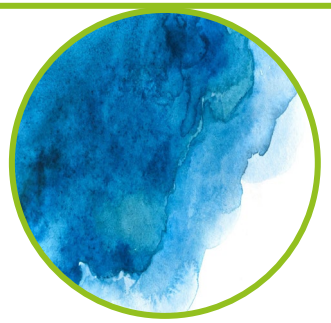


Characterization of food spoilage fungi by FTIR spectroscopy
Shapaval, V., J. Schmitt, T. Møretrø, H. Suso, I. Skaar, A. W. Åsli, D. Lillehaug and A. Kohler
Journal of Applied Microbiology 114 (2013) 788-796.

Project overview

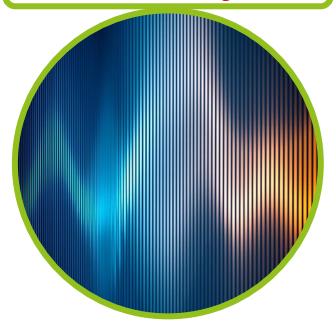
Stakeholder survey

Paper-based extraction

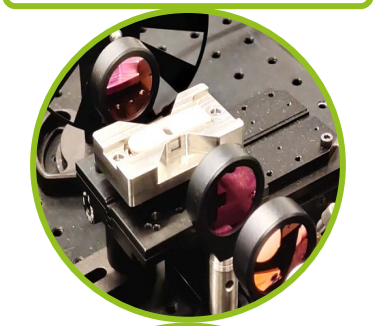


Light sources

Data analytics



Photonic devices



Demonstration

Stakeholder survey and interviews

Online survey and interviews with participants from all stages of the food chain:

Farmers

Food companies

Border inspection

Food safety authorities

Service laboratories

- LOW COST PER SAMPLE
- RAPID RESULTS
- EASY SAMPLE PREPARATION
- PORTABILITY

MI-FI target groups (in priority order):

1. Farmers
2. Food companies
3. Border inspection

- LOW DETECTION LIMIT
- RAPID RESULTS
- SIMULTANEOUS DETECTION
- MULTIFUNCTIONALITY

HI-FI target groups (in priority order):

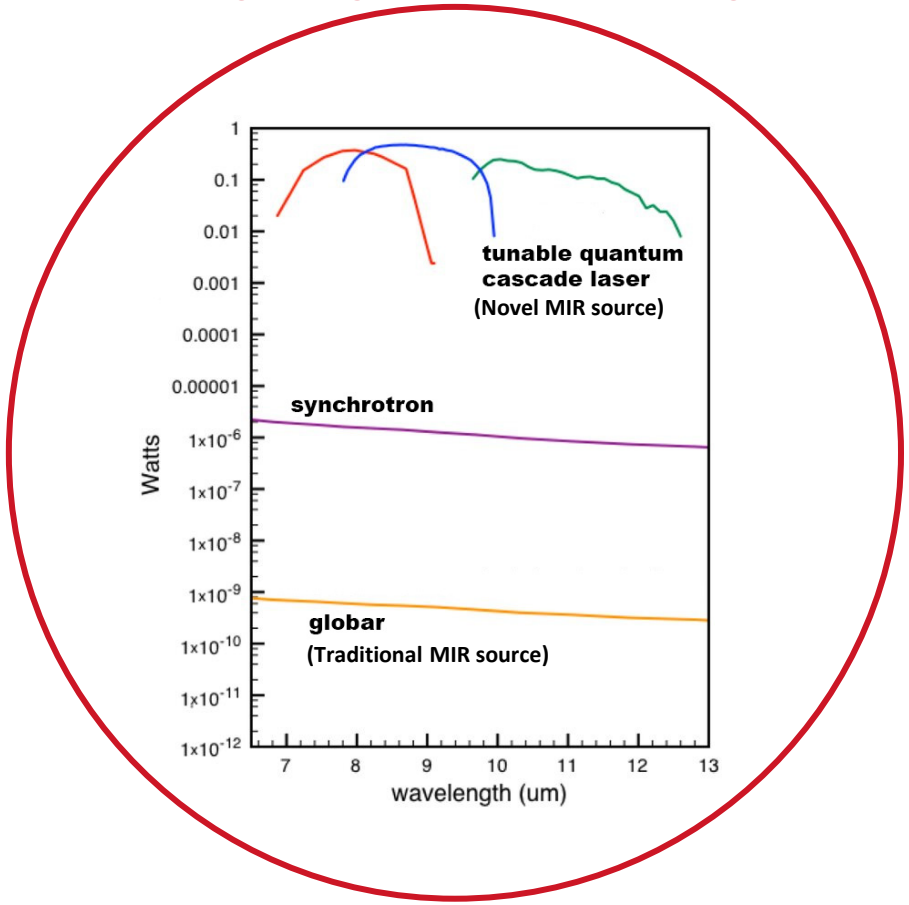
1. Service laboratories
2. Food safety authorities
3. Border inspection

Stakeholder assessment for mycotoxin analysis: exploring the demand along the European food supply chain
Csenki, E.; Mikulás, V.; Freitag, S.; Fomina, P.; Ruggeri, F.S.; Femenias, A.; et al.
Supplementary materials to World Mycotoxin Journal 2023

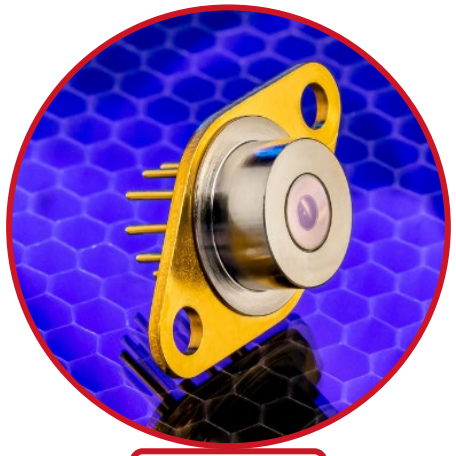
Novel light sources with high-power emission in mid-infrared enable production of smaller and cheaper sensor devices

PHOTON FOOD

Mid-infrared light brightness for various light sources

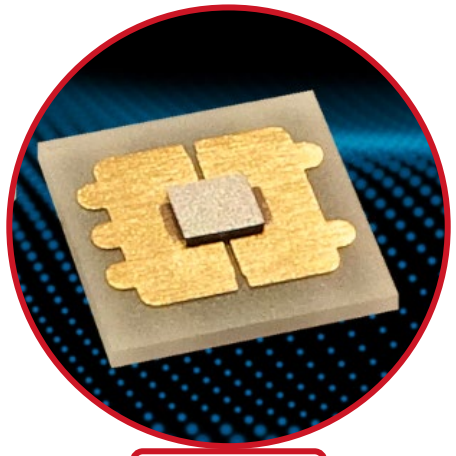


Interband cascade laser (ICL)



nanoplus

Mid-infrared light-emitting diode (ICLED)

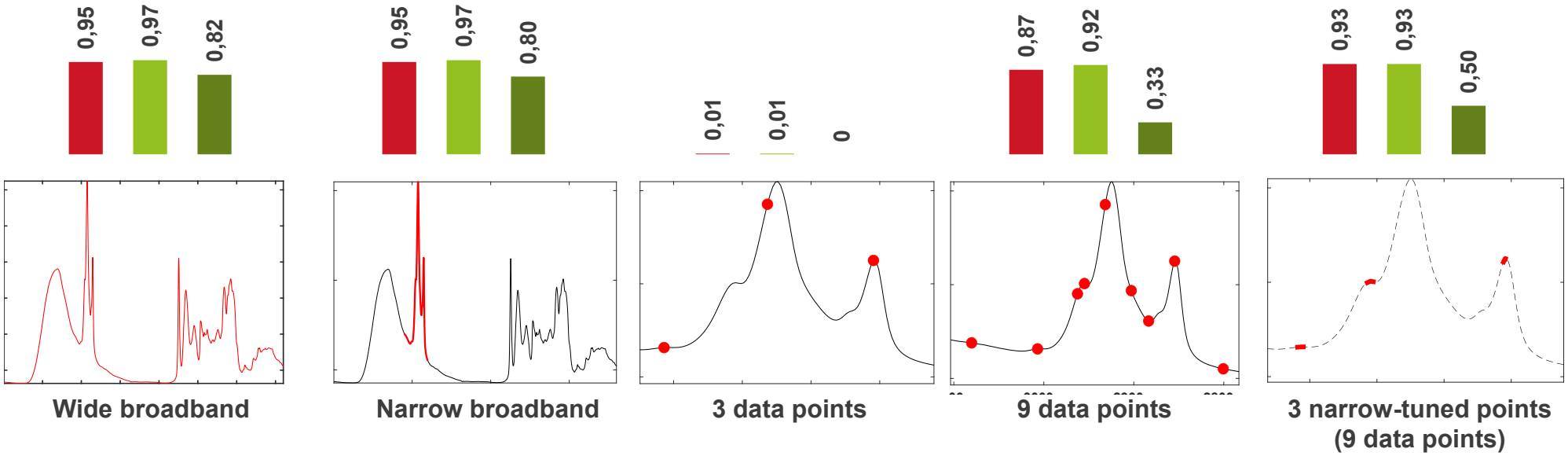


nanoplus

Excellent prediction models can be obtained for data with sparse channels and narrow spectral ranges

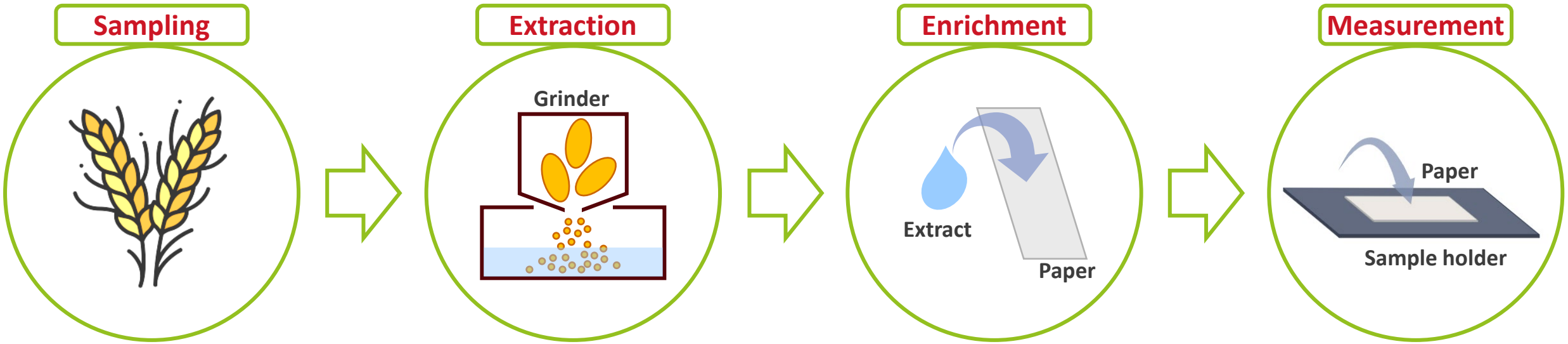
Prediction (PLSR) models for estimation of fatty acids in milk

Saturated fatty acids
Monounsaturated fatty acids
Polyunsaturated fatty acids



Sparse wavelengths data in mid-infrared spectroscopy: Modelling approaches and channel sampling
M. Aledda, A. Kohler, B. Zimmermann, N. Patel, V. Shapaval, V. Tafintseva
Journal of Biophotonics 16 (**2023**), e202300049

Selective immunoaffinity- and paper-based purification and extraction of analytes

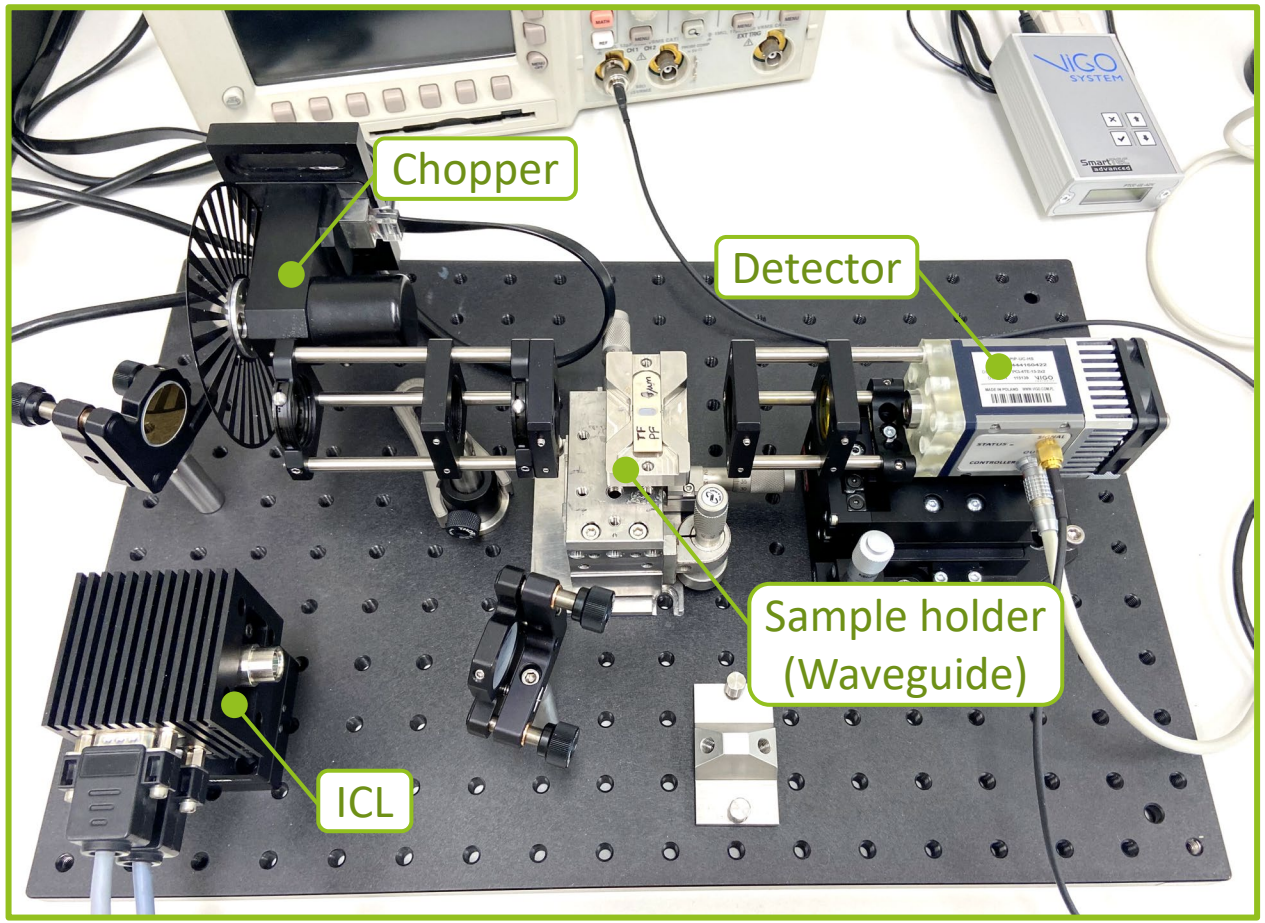


Low concentration of analyte (such as deoxynivalenol mycotoxin) prevents direct detection in complex (food) matrices

Analyte enrichment via immunoaffinity- and paper-based extraction enables direct IR spectroscopy detection

Photonic devices: HI-FI

HI-FI device: based on tunable interband cascade laser (ICL) and single-mode waveguide

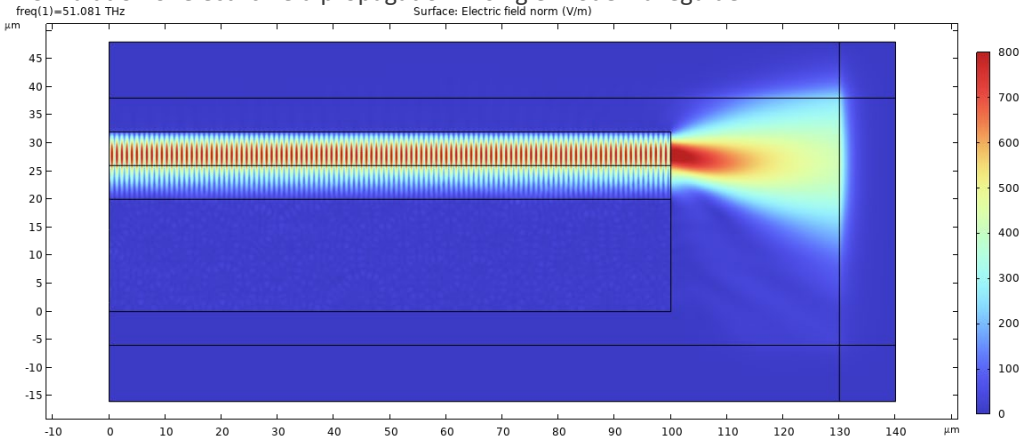


GaAs waveguide layer, 6 µm, n = 3.3197

$Al_{(0.2)}Ga_{(0.8)}As$ cladding layer, 6 µm, n = 3.2959

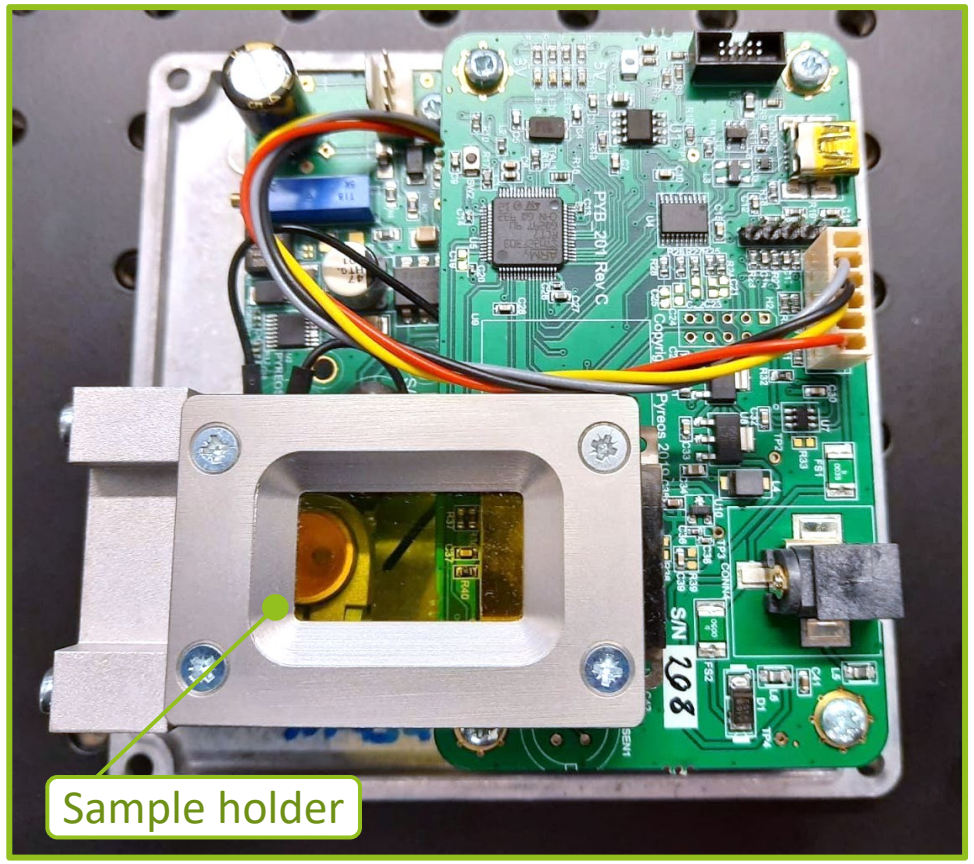
Si-doped GaAs substrate layer, 600 µm, n = 2.8

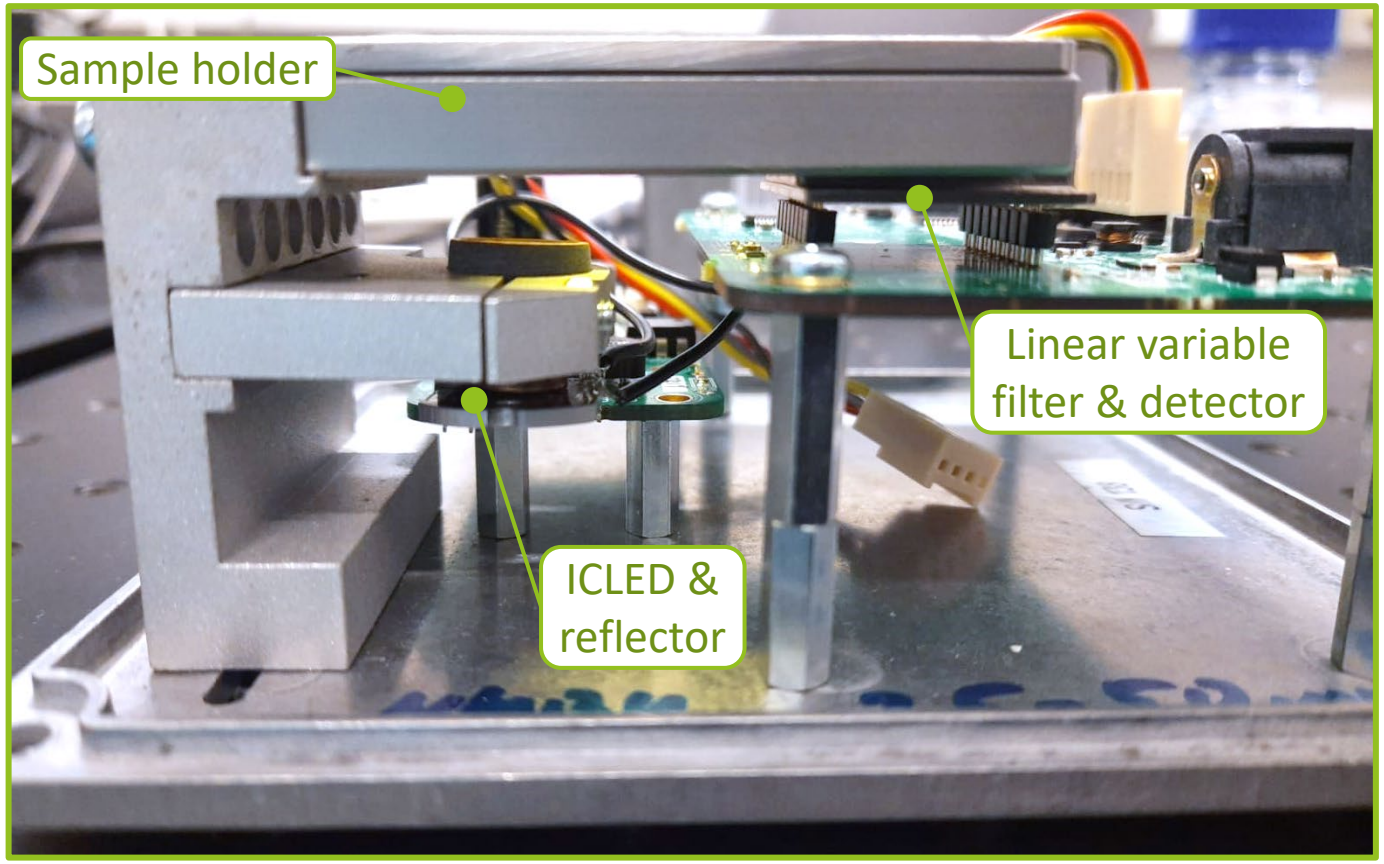
Simulation of electric field propagation in single-mode waveguide



Photonic devices: MI-FI

MI-FI device: based on low-cost mid-infrared light-emitting diode (ICLED)





Case studies: validation and demonstration

Deoxynivalenol contamination in wheat

Aflatoxin contamination in peanuts

Fungal contamination in aquaponic herb production

Save the date: Symposium

Advancements in monitoring food contamination and quality

Photonic sensors **Detection methods** **Digital solutions**

27th – 28th November 2024
Vienna (Tulln), Austria

Co-hosts:

Team at Norwegian University of Life Sciences (NMBU)

Role: Coordination and management

Main scientific activity is in data analysis, validation and demonstration

https://www.nmbu.no

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H2020-ICT-2020-2 project No: 101016444

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