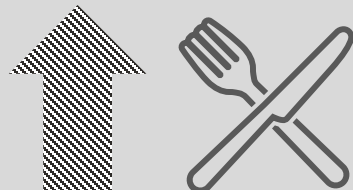# MOLOKO

Multiplex phOtonic sensor for pLasmonic-based Online detection of contaminants in milK

Final Results Presentation

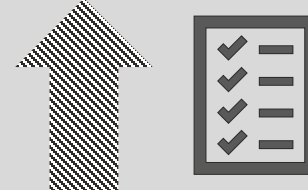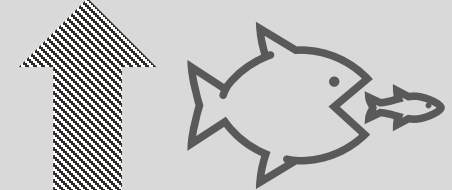# Safety and competitiveness in the dairy chain

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↑ **Contaminants in food**

↑ **Consumer expectations**

↑ **Regulatory requirements**

↑ **Industrial competitiveness**

Towards
ZERO FOOD WASTE

Need of TOOLS for self-monitoring of food parameters along the supply chain
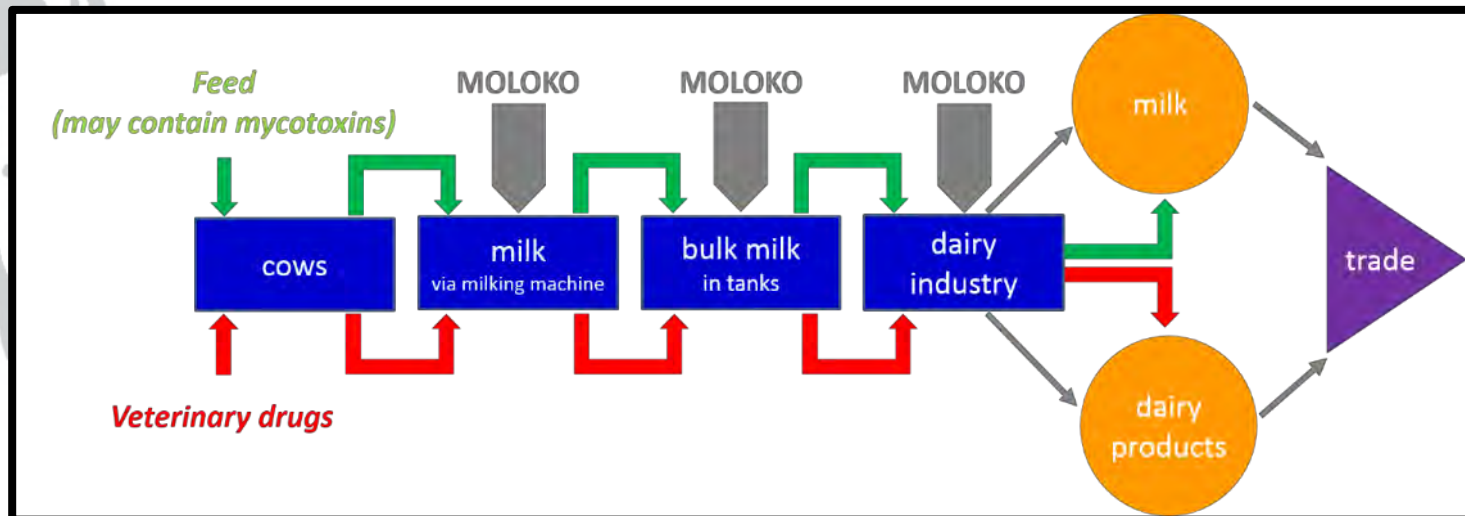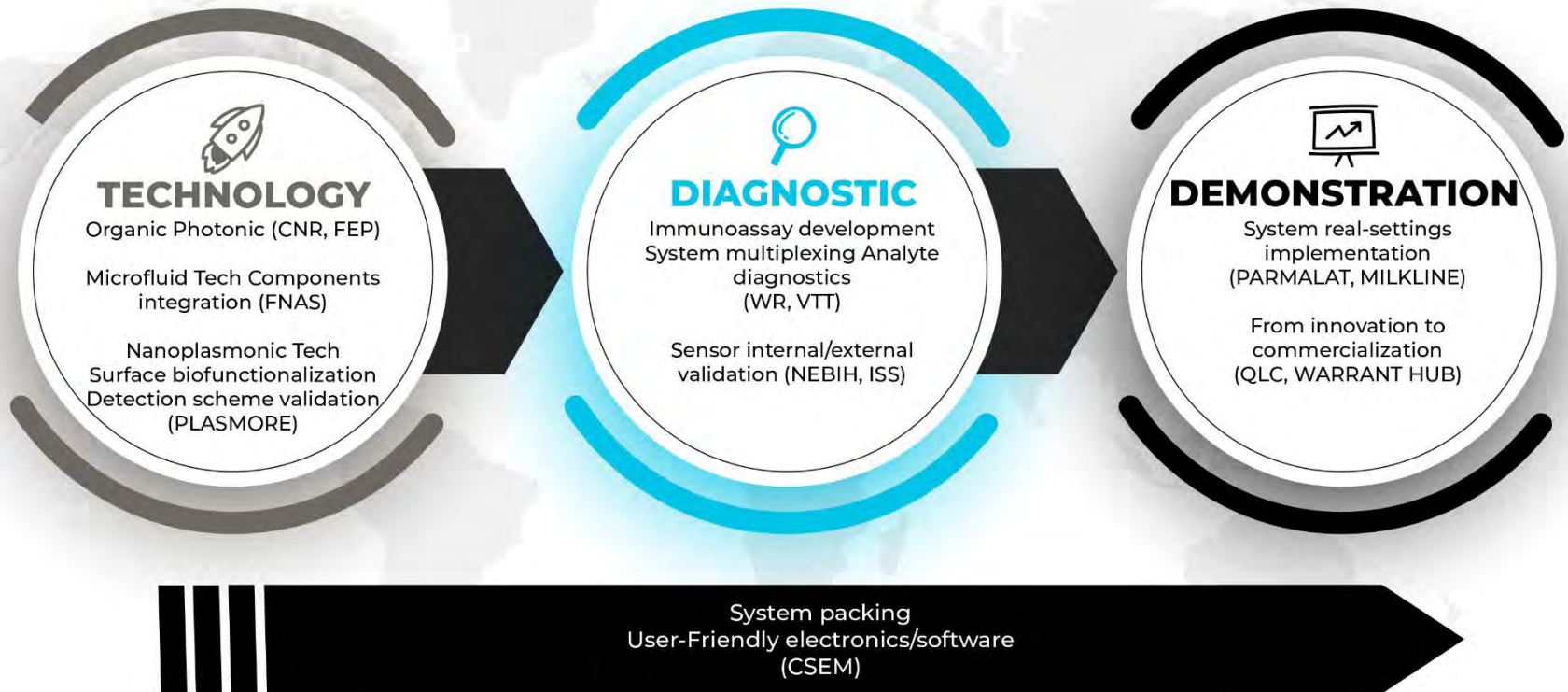
MILK

MILK

The project

MOLOKO aims to develop and validate a **self-managing and automatic miniaturized integrated photonic sensor** to be used as process analytical instrumentation for

❏ *fast response*

❏ *on-site monitoring*

to be applied in strategic checkpoints along the **entire supply and value chain of milk**

Innovation chain

TECHNOLOGY
Organic Photonic (CNR, FEP)

Microfluid Tech Components integration (FNAS)

Nanoplasmonic Tech Surface biofunctionalization Detection scheme validation (PLASMORE)

DIAGNOSTIC
Immunoassay development System multiplexing Analyte diagnostics (WR, VTT)

Sensor internal/external validation (NEBIH, ISS)

DEMONSTRATION
System real-settings implementation (PARMALAT, MILKLINE)

From innovation to commercialization (QLC, WARRANT HUB)

System packing
User-Friendly electronics/software
(CSEM)

MOLOKO

PROJECT DETAILS

PROJECT REFERENCE: 780839
START/END: Jan 2018 – March 2022
TOTAL COST: EUR 6,036,381.25
EU CONTRIBUTION: EUR 5,479,159
TOPIC: ICT-30-2017 Photonics KET 2017

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PHOTONICS PUBLIC PRIVATE PARTNERSHIP

MOLOKO SENSOR CONCEPT

Target characteristics of the device

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Self-managing and automatic

Multiplex quantitative detection of food safety and food quality parameters

User-friendly reusable

Fast-response on-site monitoring
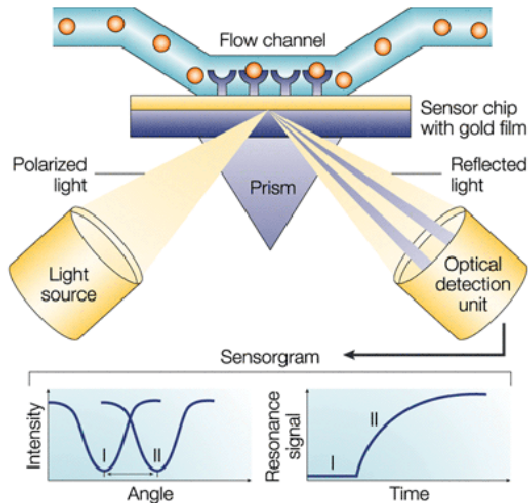
On-line analyser into milk process stream

Self-monitoring safety and quality standards

Cloud-based

Integrating innovations

Continuous, autonomous, on-site, multiplexing analytical instrumentation


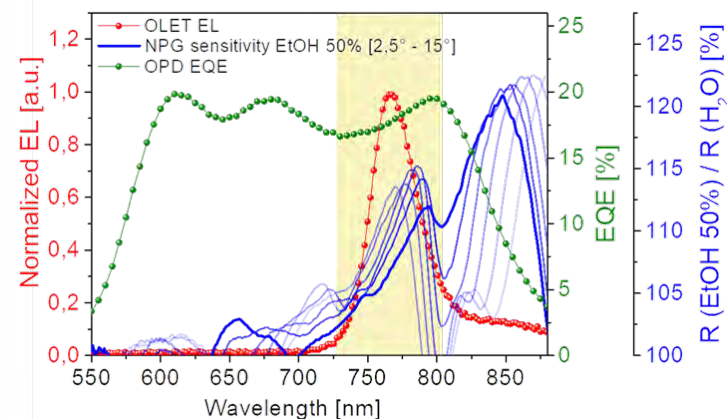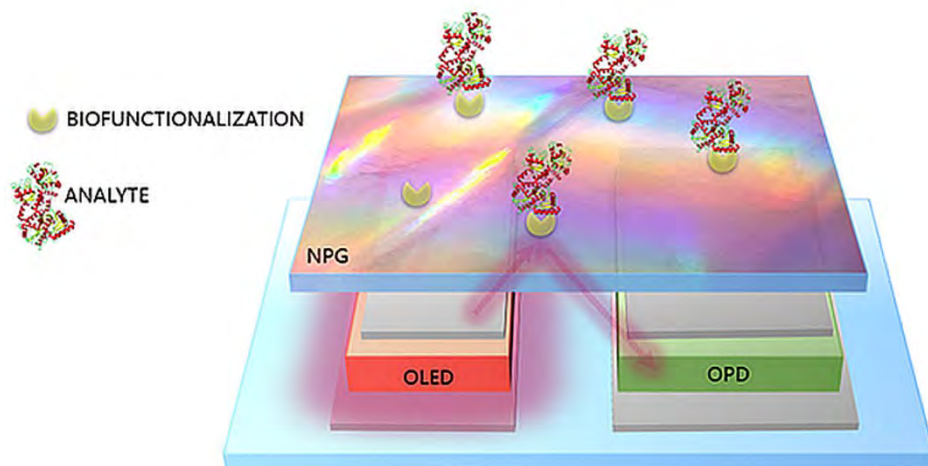**Surface Plasmonic Resonance (SPR) detection scheme based on immunoassays:**

- o routine and multiplexing method
- o robust and quantitative results
- o high specificity
- o short time
- o No labeling procedure

Microfluidic systems:

- o field deployable
- o using small samples and reagent volumes
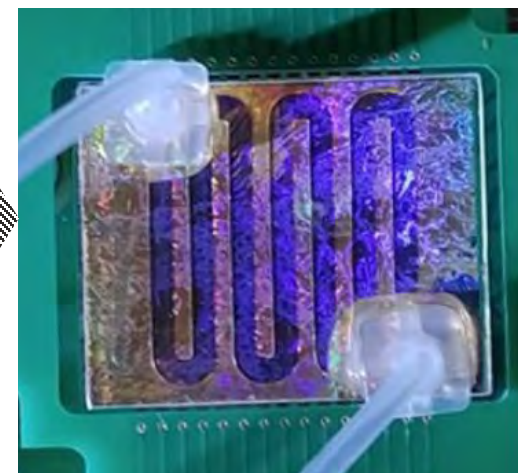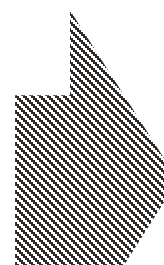- o easier waste management
- o simple to assemble

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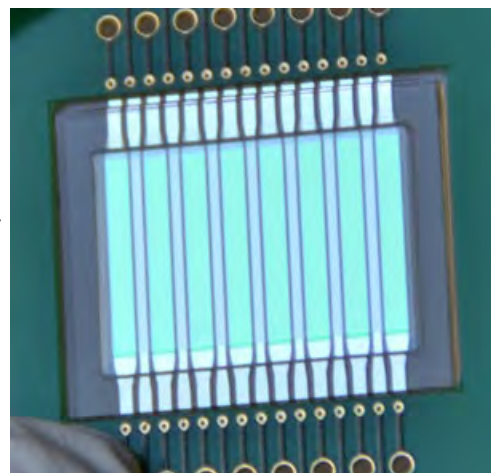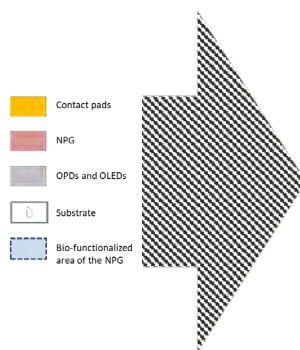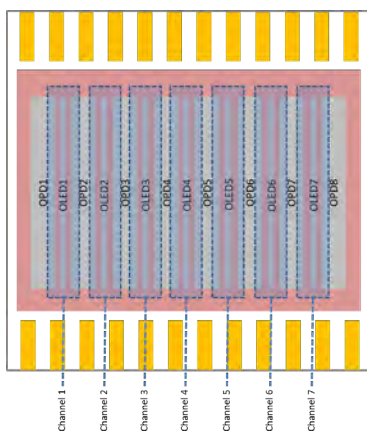PHOTONICS PUBLIC PRIVATE PARTNERSHIP
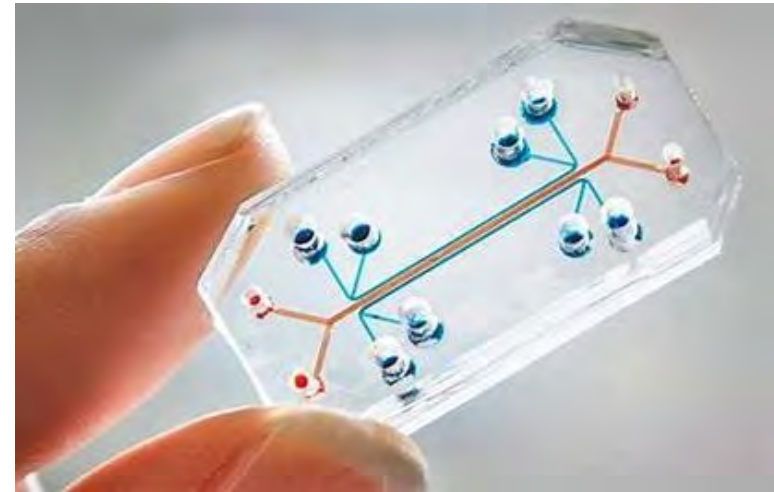
The Optoplamonic module

Organic Photonic Module

SPR Sensing Surface (NPG)

1 square-inch transparent optoelectronic chip comprised by 7 independent channels

The Immunoassay Tech

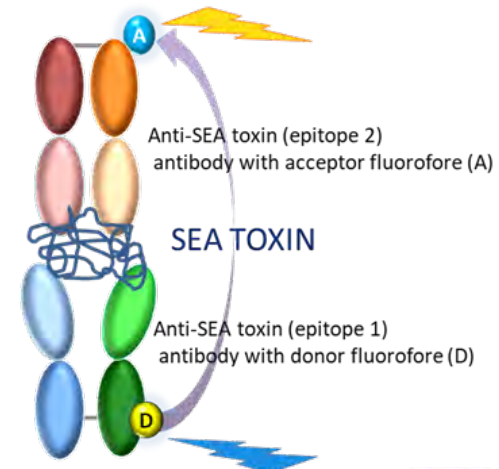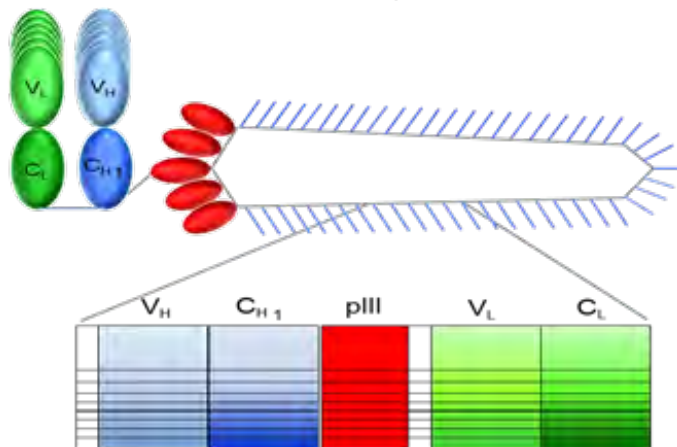**Novel antibodies for biosensing of Staphylococcus Aureus Enterotoxins**

Discovery of recombinant antibodies from libraries

❑ Millions of different antibodies/library
❑ *In vitro* semi-automated selection and screening system
❑ Large scale production in bacterial cells up to 200 Litres
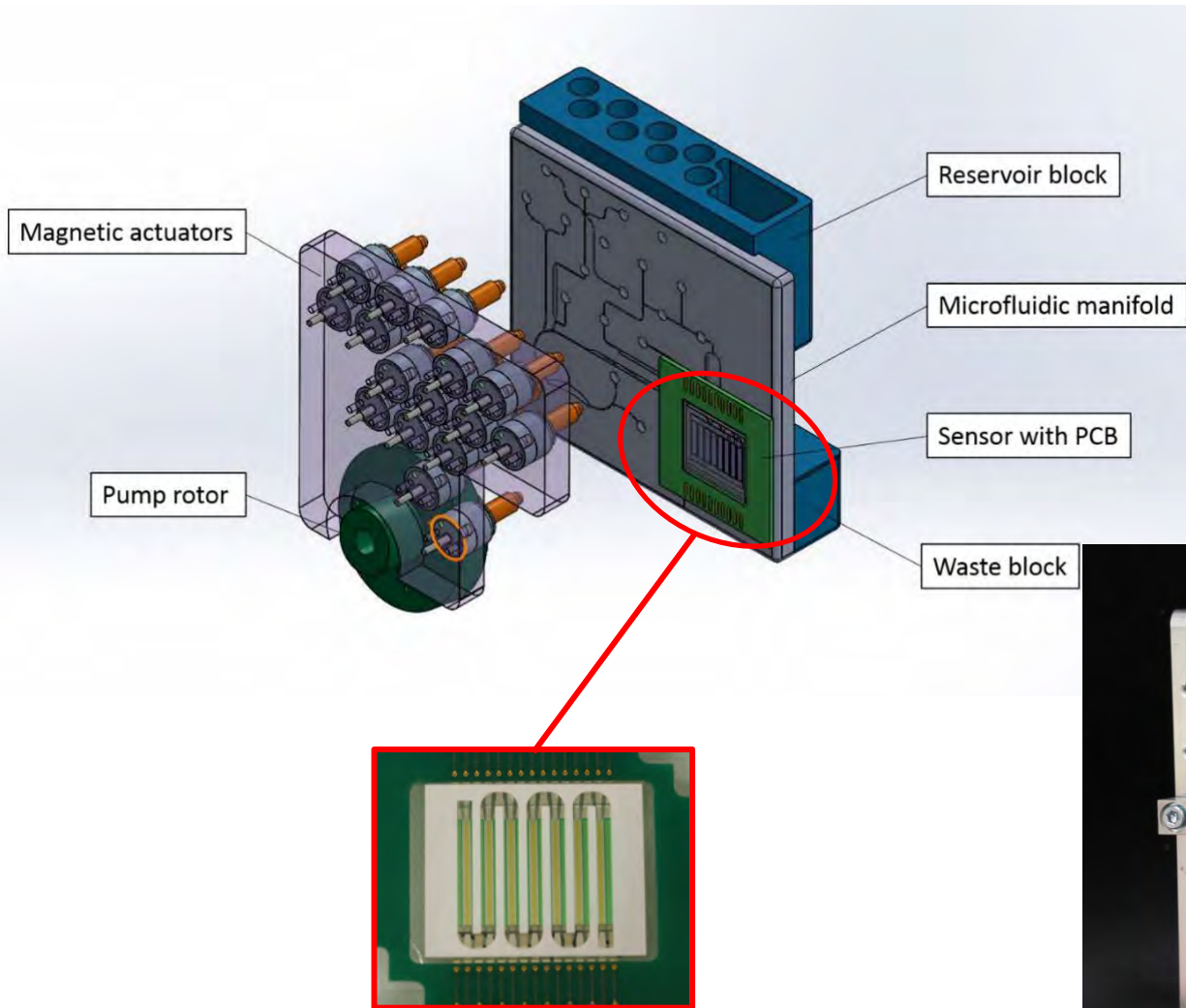
Development of immunoassay platforms

❑ Homogeneous FRET and luciferase complementation assays for SEA
❑ Use of recombinant antibodies to immunobiosensors
❑ Patent application
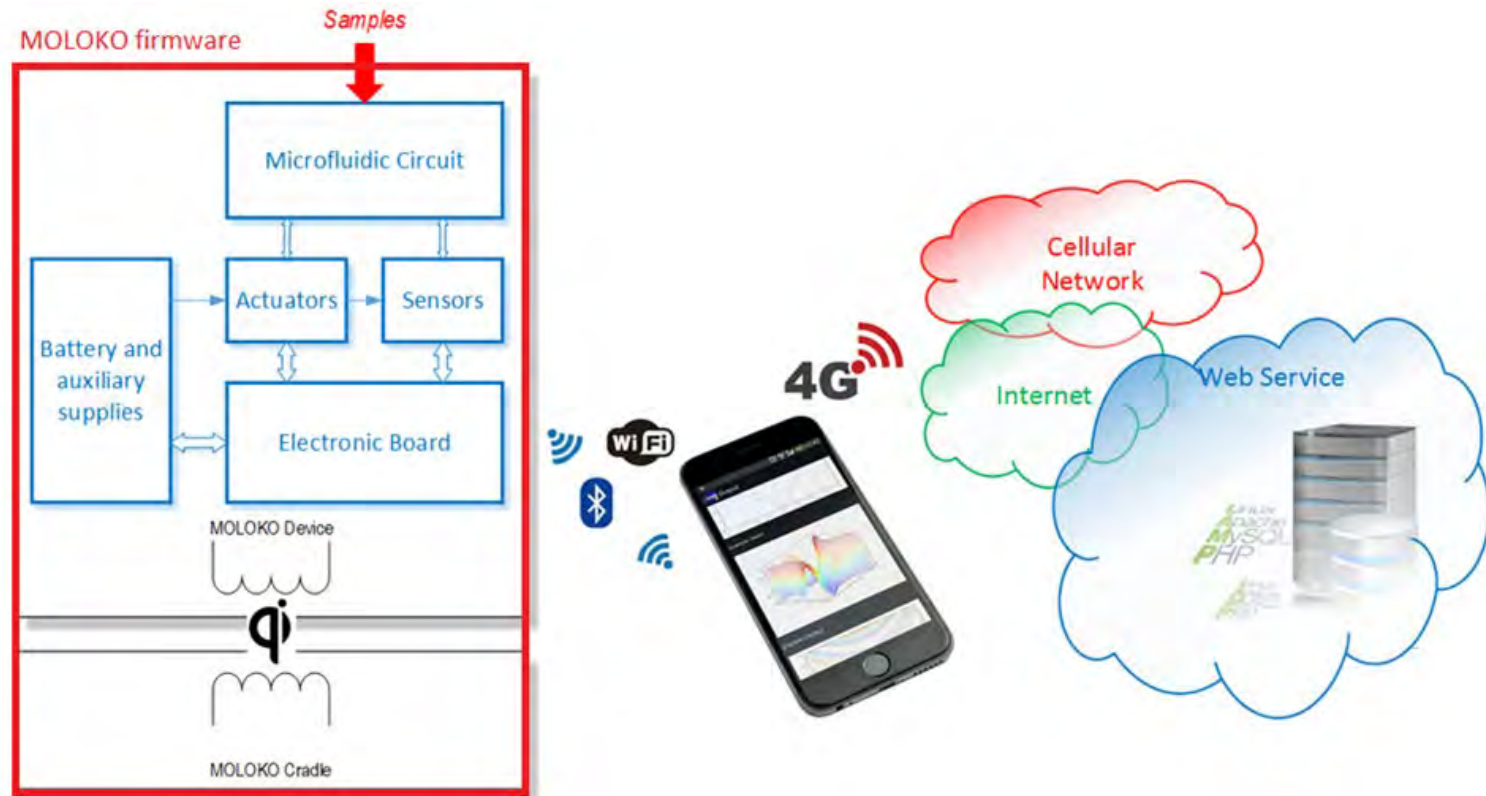
LOD < 1 ng/ml SEA in non-homogenized whole milk

The microfluidic module

Magnetic actuators

Pump rotor

Reservoir block

Microfluidic manifold

Sensor with PCB

Waste block

Enabling measure protocol in a miniaturized and automated approach

Flow channel pattern with respect to the sensor elements
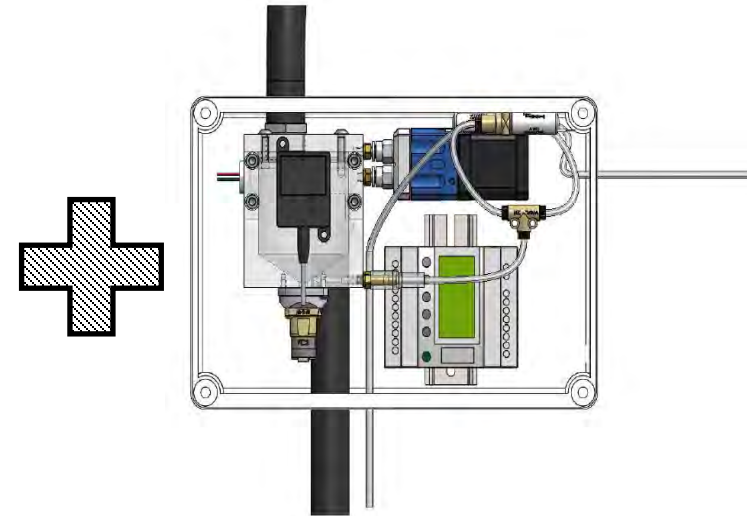
System architecture

- ❑ Electronic-board user
- ❑ Mobile-app user
- ❑ Benchtop-app user

Sensor prototyping

- ☐ Cow Milk Testing
- ☐ Bulk Milk Testing
- ☐ Supply Chain testing

Automatic Sensor

Milk Sampler

Use cases: in-field validation

❑ To diagnose the level of contaminants at the earliest in the supply chain
❑ To implement modernized risk management framework
❑ Different checkpoints of the milk chain by a single analytical instrument

MILKLINE®

parmalat

Primary producers (farmers)

Self-monitoring by food business operators

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MOLOKO SENSOR PERFORMANCE

Self-testing and calibration

❑ Linear dependence of the measured signal with respect to different concentrations of reference solutions (ethanol, sucrose)
❑ Sensitivity limit down to the scale of 100 RU (10^{-4} RIU)
❑ Channel-specific correction factor is extrapolated to be used for the quantitative assay analysis
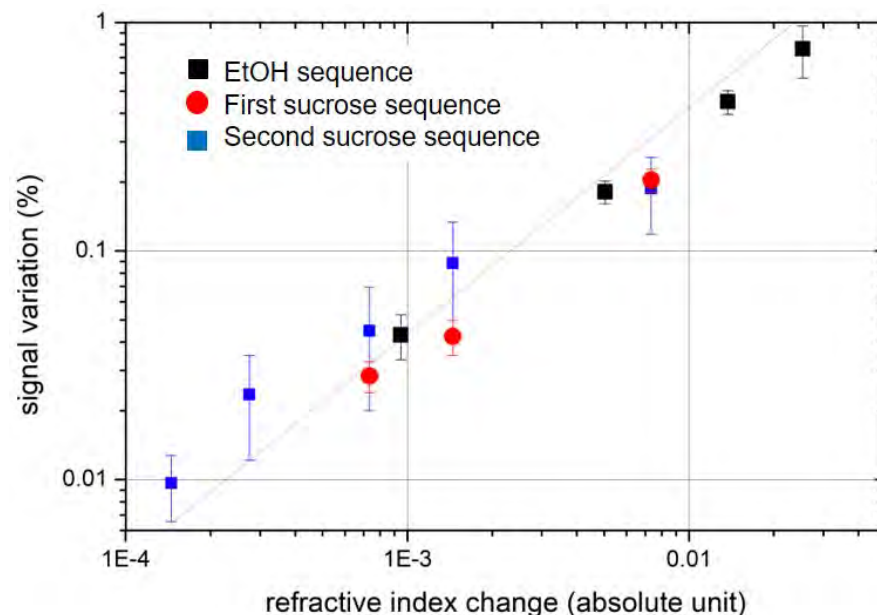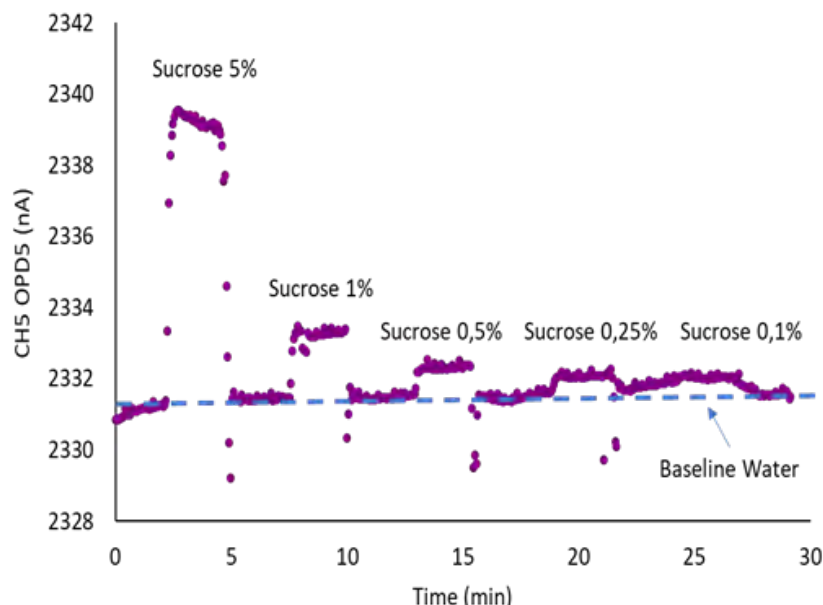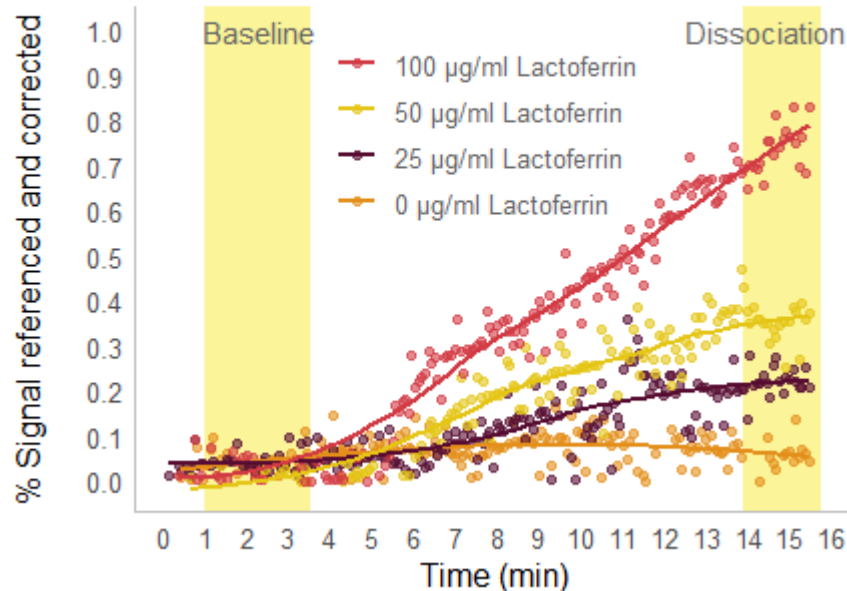
Analytical detection

Multiplex detection

Multiplexing detection of lactoferrin (quality parameter), streptomycin and quinolone (safety parameters) in buffer medium simultaneously on the same chip:

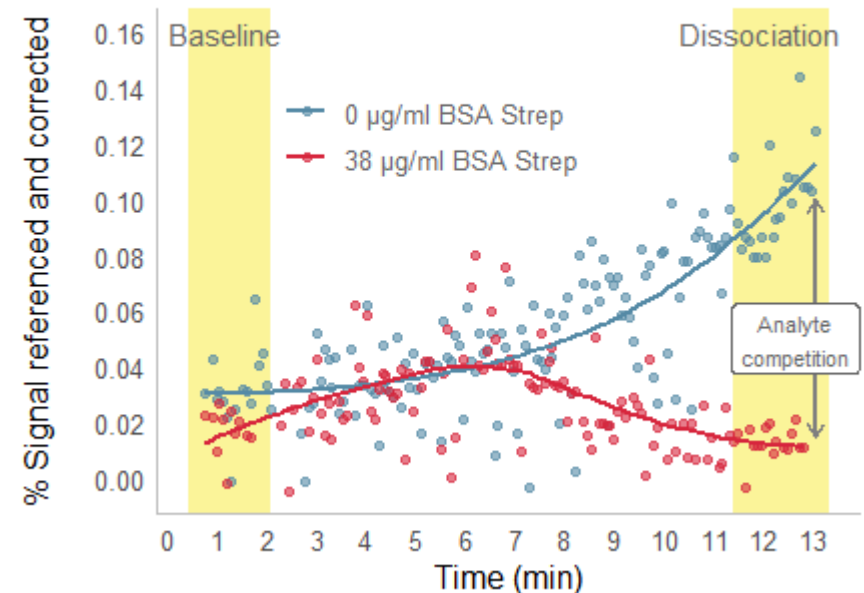*Limit of Detection (LOD) of Lactoferrin comparable to golden lab instrumentation (Biacore) at around 9 µg/mL*

Data Analysis from KODE srl

Operational use of the sensor:
the automatization

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- **Exchangeable microfluidic cartridge** for the integration with the OptoPlasmonic Module (OPM)

- The microfluidic cartridge includes a **block for the reagent storage**

- The **re-usable microfluidic module** for the integration into the readout device includes robust actuators

- The control procedure for the actuators implements all the necessary processing steps for the **automatic measurement procedure**

Operational use of the sensor:
the list of analytes

Multiplex detection

Operational use of the sensor: *Automatized analysis*

14-min long protocol of use comprising an automatized analysis of the output signal for not skilled operators

In-field demonstration of MOLOKO sensor
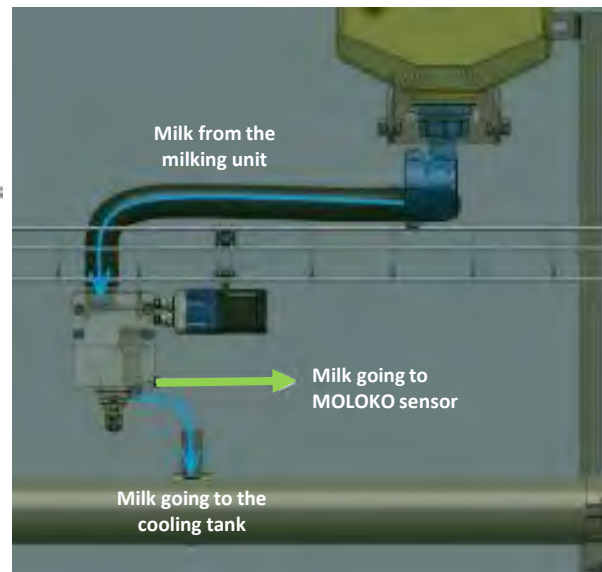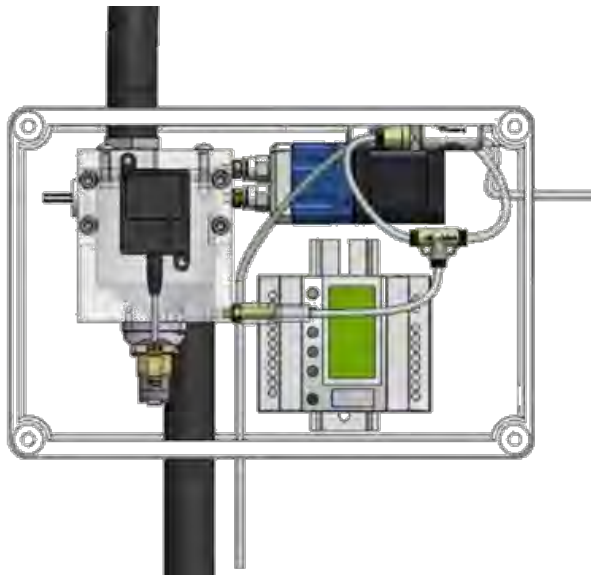
Analysis of milk

Demonstration of sensor's functionality in spiked and natural milk samples (filtered and diluted) for Lactoferrin detection.
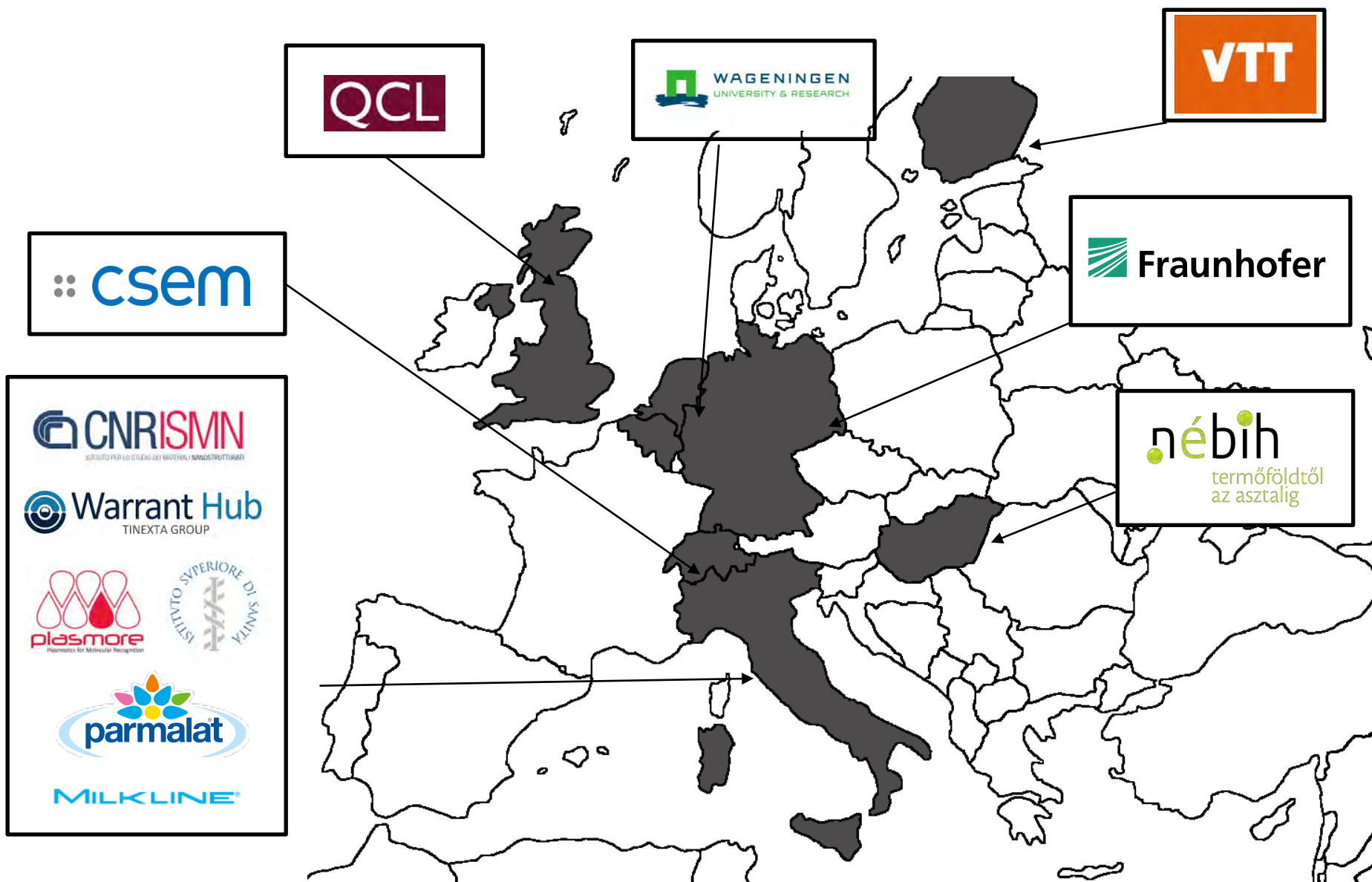
In-field demonstration of MOLOKO sensor

Integration in milking parlours

Automated composite sampler for analyser system developed and installed in a milking parlour (farm) and demonstrated on-line operation including cleaning in place (PIC)

Milk from the milking unit

Milk going to MOLOKO sensor

Milk going to the cooling tank

MOLOKO MILK SAMPLER

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Patents on novel recombinant antibodies

Specific for Staphylococcus aureus enterotoxins A and B (SEA and SEB) and cephalosporin antibiotics.

MOL⚬KO

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Partners

More info

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THANKS FOR YOUR ATTENTION

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