



Multi-modal, configurable optical lab-on-chip platform for low-cost multipurpose diagnostics & monitoring

Project overview

Challenge

Developing a miniaturized sensing platform that integrates different detection techniques for various applications, balancing contradictory specifications.

Solution

MultiLab addresses this challenge, by developing a modular multi-sensing platform compatible with wafer scale manufacturing that will integrate multiple sensing modalities to simultaneously detect biological and chemical targets for medical diagnostics and environmental monitoring



Objectives

SENSING MODALITIES

- **Develop ECL bio-sensors for Biomarker Detection**

Fabricate enzyme-based ElectroChemiluminescence (ECL) sensors on low-cost, all-graphite inkjet-printed 3-electrode cells for detecting biomarkers like lactate, uric acids, O_2 and H_2S .

- **Develop PA-AWG sensor**

Integrate an Al plasmonic waveguide in a Plasmonic augmented Arrayed Waveguide Grating (PA-AWG) module to enable simultaneous detection of proteins, miRNA and microorganisms with high scalability and cost-efficiency.

- **Develop mid-IR Photothermal Spectroscopy (PTS)**

Develop PTS sensors for label-free multi-component analysis in the mid-IR range, initially using Mach-Zender Interferometers (MZI) and exploring AWG integration for enhanced performance.

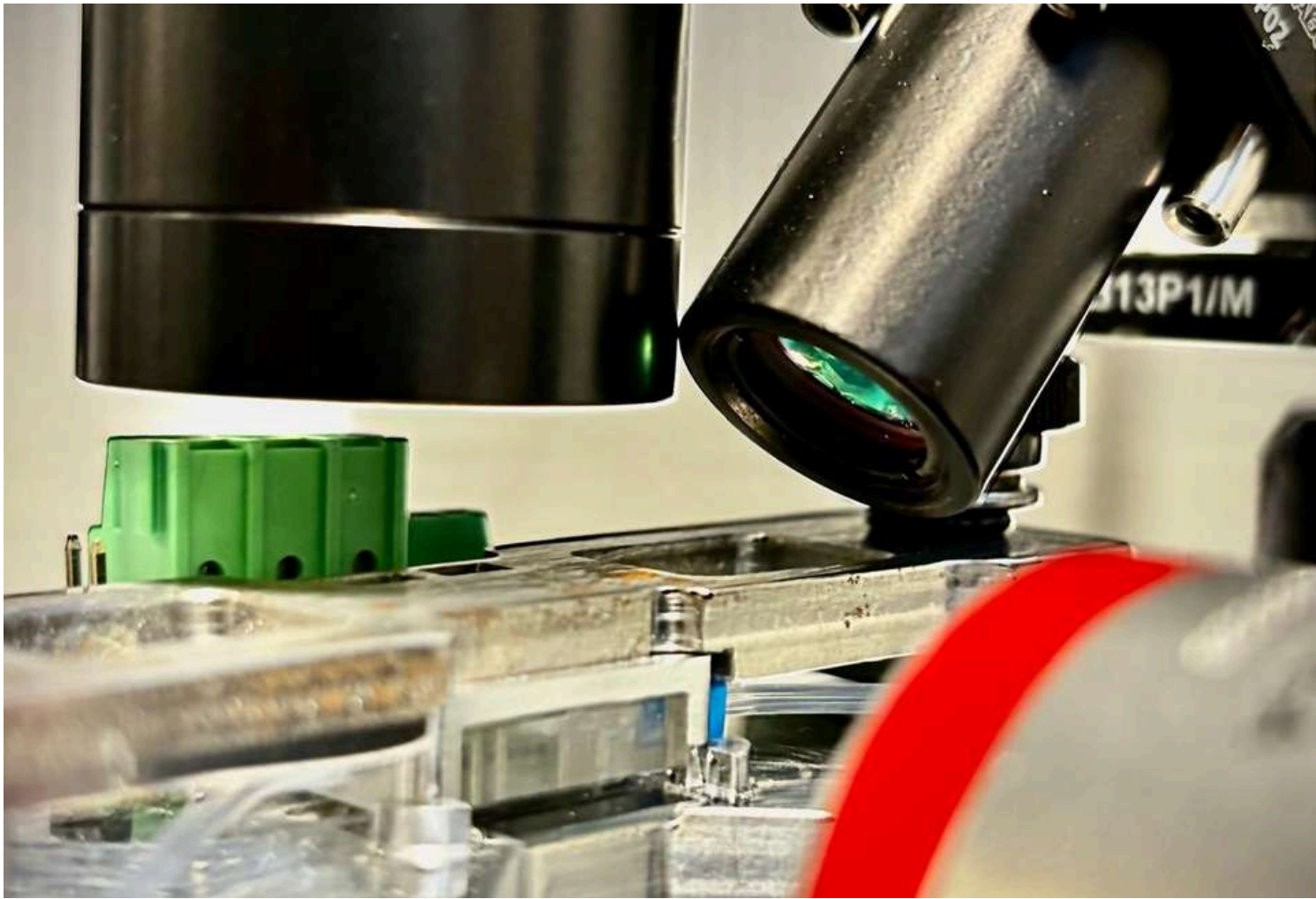
Integrate and validate multi-modality optical sensing platform

Create modular PICs with CMOS-compatible Si_3N_4 photonics and interchangeable bio-sensing modules, combining them with customized microfluidics to improve sensitivity and reduce measurement time.

Develop Machine Learning approaches

Use ML to analyze multiplexed sensor data, implementing advanced techniques.





MultiLab Integrated Instruments v1

The MultiLab Integrated Instrument v1 marks a major leap toward compact, multimodal optical diagnostics. By merging three powerful sensing technologies into one platform, it enables real-time, versatile biochemical and environmental analysis. This milestone prototype showcases seamless integration of optics, microfluidics, and data intelligence in a single lab-on-chip system.

ECL sensor

The MultiLab ECL module brings dual-zone, time-resolved detection into a compact lab-on-chip format.

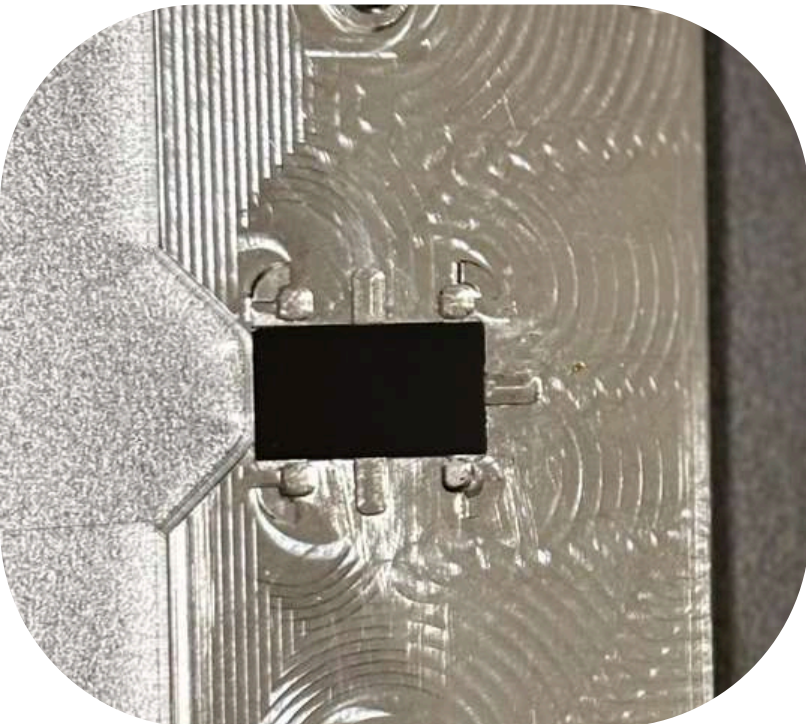
- High-sensitivity imaging captures even weak emission changes
- Fully synchronised with potentiostat bias control for accurate reaction timing
- Ray-traced optics ensure precise focusing and uniform illumination
- Reusable in seconds: automated rising and regeneration after each test



PA-AWG sensor

A PA-AWG enables refractive index sensing with $\text{LoD} < 10^{-6}$ RIU

- Eight-channel interferometric readout
- Real-time imaging for sub-pm spectral mapping
- AI-ready outputs support future ML classification of biosignals
- Validated integration with shared optics and microfluidics on the same chip



PTS sensor

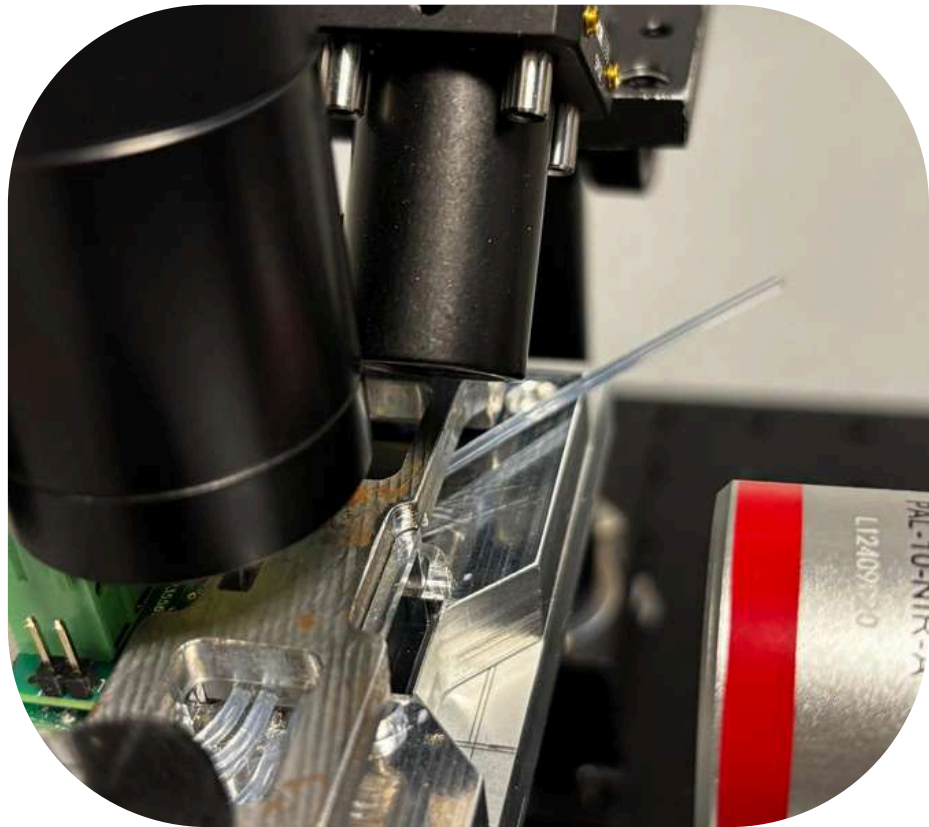
The PTS-MZI module detects nutrients in water by converting molecular absorption into refractive index shifts.

- Dual-beam excitation for ultra-sensitive photothermal spectroscopy
- Lock-in detection enhances signal-to-noise ratio for improved detection
- Shared optics with PA-AWG streamline integration

Microfluidics & sample delivery

The MultiLab Microfluidics Mechanical Clamping (MultiMEC) system secures chip alignment and leak-free operation.

- Transparent PDMS/COC hybrid enables optical access
- Syringe-based system tested for 0.05–2.5mL, 30–430 μ L/min flows
- Integrated GUI for intuitive control and calibration
- Supports dual-channel flow for reference/sample delivery



Integrated Readout System

A single optical readout system unites VIS, SWIR and MIR sensing

- Dual camera setup for simultaneous multimodal detection
- Modular and synchronised light, electrochemistry, and fluidics control
- Compact mechanical design supports future automation and portability

Data platform

Data acquisition provides real-time control and processing

- Outputs standardised sensograms with full metadata
- REST API connectivity links directly to the MultiLab cloud platform
- Ready for ML-based analysis and visualisation in both case studies workflows

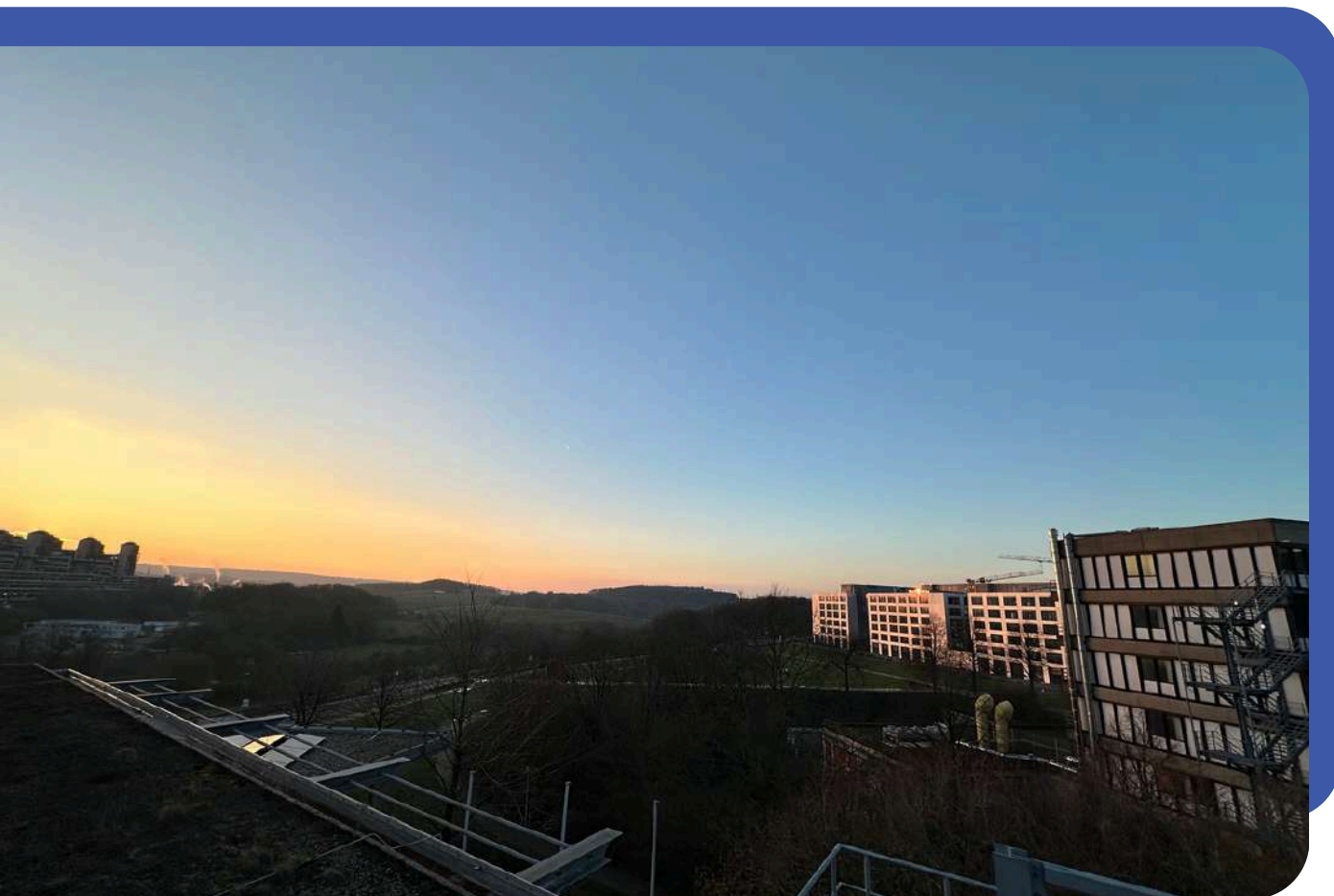
24M Consortium Meeting

On November 26-27, the 24M Consortium Meeting took place in Aachen, Germany, hosted by our valued partner, AMO.

This two-day meeting brought together all consortium members to:

- ✓ Review the project's progress over the past 12 months.
- ✓ Share updates
- ✓ Address technical challenges and solutions.
- ✓ Set clear action plans for the next six months.







Laser World of Photonics 2025

MultiLab was presented by CYRIC, in the Laser World of Photonics 2025 Conference, presenting an overview of the project, its objectives and recent technical achievements.

IMA 2025, nanoBALKAN 2025

At IMA 2025, MultiLab was presented by UOI, and its highlights in integrated materials analysis workflows. In addition, UOI, presented the project in nanoBALKAN 2025 and its cross-disciplinary nanotechnology applications.



Web Summit 2025

MultiLab was presented by CYRIC, in Web Summit 2025 conference, showcasing how advanced laboratory technologies

Contact

Wrapping up our second newsletter edition, we're thrilled by the progress within our MultiLab project.

With gratitude to our partners, we stride into the future, eager to pioneer advancements in medical diagnostics and environmental monitoring.

Stay tuned for updates as we revolutionize the field through technology and commitment.

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