Photonics21 Press Release

https://www.youtube.com/watch?v=BR4ED8fcL_o

Photonics: New Sensor to Track Hidden Water Pollutants in Lakes and Rivers

An EU consortium is developing a new photonic sensing platform to track invisible threats from petrochemicals, pesticides, heavy metals, and industrial waste in our rivers, lakes, and oceans – helping to prevent environmental disasters before they escalate.

The European Commission has invested €4.6M to develop a super, multi-sensing platform that combines photonics – the science of light – with electrochemistry to detect hidden toxins and pollutants, which conventional monitoring devices often fail to catch. This new multi-sensor uses lasers and photonic circuits to offer a cheaper, more sustainable solution than currently available technologies.

With climate change, industrial expansion, and even geopolitical conflicts increasing the strain on Europe's water systems, the need for continuous environmental water monitoring has never been greater. But, this EU-funded project, called 'IBAIA', is set to transform how we track and manage water pollution, enabling authorities and industries to detect contamination before it causes irreversible damage to ecosystems and water-dependent sectors.

Radwan Chahal, Project Manager at IBAIA, said: "Environmental water pollution might be one of the most urgent yet overlooked crises of our time. However, IBAIA's sensing technology is set to become a gold standard in water monitoring, protecting our health and our environment."

Industrial and agricultural activities release a complex mix of chemical pollutants into rivers and coastal waters, threatening ecosystems and water quality. Advances in chemical analysis have revealed that many of these contaminants – such as hydrocarbons, drug residues, or nutrient salts like nitrates and phosphates – are present in far greater quantities than previously recognised. Their combined effects, often referred to as the "cocktail effect," remain poorly understood but have been linked to serious concerns, including immune system weakening, reproductive issues, congenital anomalies, and even cancer risks.

For decades, water quality testing has relied on laboratory analysis, where samples are collected and examined using complex techniques like mass spectrometry and chromatography. While highly accurate, this method is slow, expensive, and reactive, often taking days or weeks to detect contamination. By the time a pollutant, such as a pesticide or microplastic, is identified, it may have spread unchecked, putting public health at risk. The high costs and limited availability of lab facilities also mean testing is infrequent, leaving dangerous gaps in monitoring.

Four Sensors, One Platform

The IBAIA's multi-sensing system integrates four different detection methods into one single solution. This 'super sensor' offers unmatched accuracy and the ability to detect more

pollutants across a wider range of substances, setting a new standard for pollution detection and prevention.

The platform works by using a blend of photonics and electrochemical sensors to detect pollutants that current technologies miss. Unlike older systems that require lab tests and delays, IBAIA's sensors provide real-time, in-situ data. This means immediate detection of dangerous pollutants and much quicker responses to contamination events.

Mid-Infrared (Mid-IR) Sensor – Detecting Organic Chemicals

IBAIA uses mid-infrared light to identify and measure organic chemicals in water, such as pesticides, industrial solvents, and oil residues.

Mid-IR spectroscopy operates on the principle that every chemical leaves its own spectral 'fingerprint' when exposed to infrared light. This sensor reads those signatures with great precision, pinpointing even the faintest traces of industrial waste or oil residues before they enter our water supplies.

"Real-time detection means swift intervention," explains Izabella Otalega, Research and Innovation Manager at Modus Research and Innovation. "Pollution can be intercepted before it spreads, and environmental agencies can act before contamination spirals into crisis. In a world where toxic spills and chemical leaks have often been discovered only when it's too late, speed and accuracy are essential."

Visible-Near Infrared (Vis-NIR) Sensor – Detecting Microplastics and Salinity

Taking a sip of crystal clear freshwater, you might believe you are drinking or swimming in something pure. But upon closer inspection, the truth can be unsettling. Microplastics, the insidious remnants of our disposable culture, and chemicals are everywhere, drifting through rivers and oceans and even making their way into our food.

Detecting these microscopic invaders has been a laborious and costly process, relying on methods so painstakingly slow that by the time pollution is identified, it has already spread and settled into ecosystems. However, the IBAIA Vis-NIR 'super sensor' uses visible and near-infrared light to detect microplastics instantly before they vanish into the currents.

"Microplastics absorb and reflect light in distinctive ways, which are invisible to the naked eye but glaringly obvious to the precision optics of IBAIA's sensor. In a fraction of the time, it can scan and identify these contaminants in water sources, offering real-time tracking of plastic pollution, at scale, across oceans, rivers, and even drinking water supplies," Otalega said.

Optode Sensor – Measuring Physicochemical Parameters

This sensor measures key physicochemical parameters such as pH, oxygen levels, and temperature.

Water pollution doesn't always arrive in obvious forms like oil spills or plastic waste. Often, the first signs of trouble are invisible: subtle shifts in pH, oxygen levels, or temperature that indicate a deteriorating ecosystem. The IBAIA Optode sensor is designed to catch these changes early, providing a real-time, cost-effective method for monitoring water health before a crisis unfolds.

Using chemical-sensitive dyes that react to environmental conditions, the sensor delivers precise, continuous measurements of key physicochemical parameters. Unlike traditional monitoring methods, which often require delayed lab testing, IBAIA's technology allows conservation teams and agencies to act swiftly, preventing pollution events before they escalate.

Electrochemical (EC) Sensor – Detecting Nutrient Salts and Heavy Metals

Among the most serious threats to water quality are pollutants like nitrates, phosphates, and heavy metals such as lead, mercury, and arsenic. The IBAIA Electrochemical (EC) sensor is designed to detect these contaminants in real time, allowing for faster, more efficient monitoring than traditional lab-based methods.

Electrochemical sensors work by measuring the electrical response of these substances when they interact with the sensor surface. IBAIA's electrochemical sensor analyses the electrical reaction upon contact with the sensor's surface while also identifying nutrient salts that contribute to harmful algal blooms, all in real-time.

IBAIA's system will be tested in real-world conditions, with field trials across Europe at the end of the project. The technology is expected to be fully validated within the next few years, offering a game-changing tool for tackling water pollution across the continent.

The project, which is set to conclude in 2026, brings together a consortium of partners from across Europe, combining world-class expertise in photonics, electrochemistry, environmental science, and water monitoring technologies.

Coordinated by CNRS (Centre National de la Recherche Scientifique, France), key research institutions include Université de Rennes, LAAS-CNRS, Tampere University, Université de Mons, Universität Duisburg-Essen, University of Pardubice, and the University of Eastern Finland. Industry partners such as MIRSENSE, KLEARIA, Argotech, VIGO Photonics, and MICROLIQUID contribute cutting-edge sensor technologies, while environmental research organisations IFREMER, BRGM, and the Leibniz Institute for Photonic Technologies ensure real-world validation. Modus Research and Innovation (UK) oversees communication and innovation management, supported by UKRI funding (grant number 10062902).

End-user partners CEDRE (accidental pollution remediation) and SCIRPE (phytoremediation wastewater treatment) play a crucial role in defining key pollutants for testing. Their expertise ensures that IBAIA's solutions directly address critical contamination challenges, supporting industries and environmental agencies across Europe.

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About IBAIA

https://ibaia.eu/

IBAIA aims to develop four novel optimally functionalised sensor modules for detecting organic chemicals, nutrient salts, heavy metals and microplastics, as well as measuring salinity and physicochemical parameters. The four sensors will be designed, tested, and packaged into a modular advanced multi-sensing system, offering a one-size-fits-all solution for many end users and providing technological innovation to help the European Green Deal actions be met.