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PHOTONICS PUBLIC PRIVATE PARTNERSHIP

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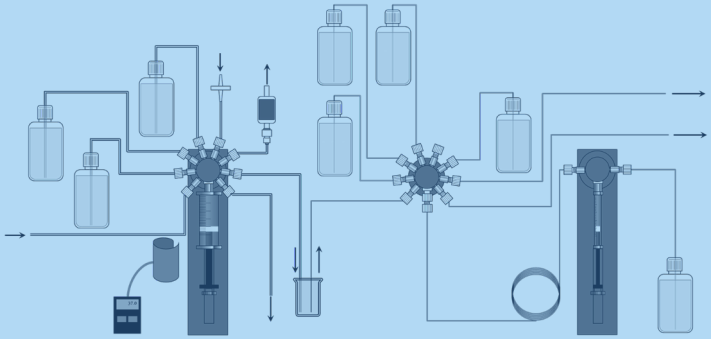
WATERSPY

High sensitivity, portable photonic device for thorough water quality analysis

www.WaterSpy.eu

What is WaterSpy?

WaterSpy is a device for pervasive and on-line monitoring of tap water.
For many contaminants, which will lead to human health hazards, good measurement devices are available. For bacterial contamination the situation is worse. Water utilities, public authorities and regulators rely heavily on trustable and fast water analysis. Especially *E. coli*, *Salmonella* and *P. aeruginosa* are of interest for human health. Currently time-consuming and expensive laboratory analysis have to be performed. WaterSpy focuses on these three strains of bacteria and develops an add on device for currently available quality monitoring platforms. The device will be able to perform automated and fast quality analysis for bacterial contaminants in water.
Challenges of the project are to meet the legal requirements for the concentration of contaminants, given in the EU directives on water quality. Due to the very low acceptable concentration of contaminants, the sensitivity of the device has to be very high to catch up with current laboratory analysis.



The WaterSpy incubation module automatically grows the target bacteria and cleans itself after the pre-incubation step is finished. The pre-incubation step is needed to meet the required sensitivity demands.

Approach and Objectives

- Key Strategic Objectives:
  - Develop compact photonics technology, capable of identifying selected heterotrophic bacterial cells in the water. Specificity and sensitivity levels will respect regulatory requirements.
  - Validate the technology's cost-effectiveness and suitability for large area coverage.

- WaterSpy develops water quality analysis photonics technology suitable for inline field measurements operating in the mid-infrared region (6-10 µm).

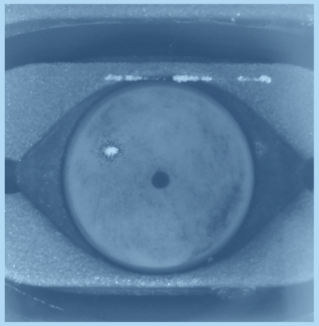
- The solution is based on the combined use of advanced Quantum Cascade Lasers employing the Vernier effect and fast and sensitive Higher Operation Temperature (HOT) photodetectors.

- Targeted analytes will be specific heterotrophic bacterial cells. Several novel techniques are employed for increasing Signal-to-Noise Ratio.

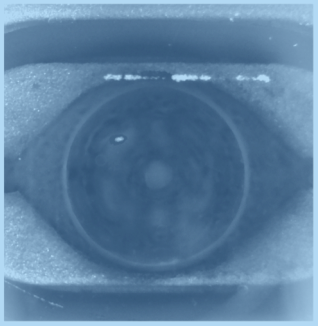
- The device will require about 6 hours for a complete sample analysis. With currently used systems, the same analysis could take up to 3 days.

- The WaterSpy technology will be integrated, for validation purposes, to a water quality monitoring platform, in the form of a portable device add-on.

- Towards the end of the project, the WaterSpy device will be tested at two pilot sites:
  - The Prato water treatment plant, which serves the city of Genova (approx. 580000 inhabitants).
  - The entry point of the Genova water distribution network.



Beads



E. coli

State and Achieved Goals

- The development of a pre-incubation module has been finished. This module enables a significant increase of sensitivity of the WaterSpy device. A sketch is given in the image at the bottom left.

- The optical test setup using an ATR-cell (attenuated total reflection) has been improved, which resulted in a higher Signal-to-Noise Ratio.

- The signal processing software was optimised to compensate for drift and optical resonances in the setup.

- The acoustofluidic cell paired with the ATR optics for the final concentration of the water sample was optimized to be robust against gas bubbles in the cell, which may occur at any time during the liquid handling procedure.

- Concentration via the acoustic trap was improved and tested with *E. coli* bacteria and beads. The images in the middle show concentrated samples, which are reliably held by the ultrasonic radiation forces.

- The first prototype of the WaterSpy device, which included all submodules was set up and tested at a TUW laboratory. This was the first time, that all modules were tested in an overall system and automated measurements have been performed. Also the control software and signal processing was tested.

- The current approach, which is needed for concentrating only the target bacteria was successfully tested. Attaching anti-bodies against the target bacteria is currently under process.

- The preliminary version of the IR detection module has been finished. In order to increase setup sensitivity by increasing the signal-to-noise ratio, the infrared balanced detection module, utilizing two well-paired MCT detectors has been designed and manufactured. This version has implemented two operation modes: balanced and auto-balanced. The auto-balanced mode uses the low-frequency signal as an error signal, which is then used to compensate for thermal drift and environment temperature changes.

- The current development is moving towards the first integrated WaterSpy device, which will be tested at a water treatment plant in Italy.