The Challenges

Pervasive and on-line water quality monitoring data is critical for detecting environmental pollution and reacting in the best possible way to avoid human health hazards

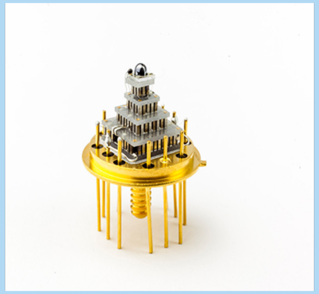
Challenge 1:
It's difficult to gather pervasive and on-line water quality monitoring data, for most contaminants mentioned in EU Directives on water quality

Challenge 2:
There is no device on the market able to provide high sensitivity and selectivity in on-line analysis of water quality parameters

Challenge 3:
Water utilities, public authorities and regulators rely heavily on frequent sampling and laboratory analysis. This is time-consuming and expensive

Challenge 4:
Compact, portable and high-performance devices for pervasive water quality monitoring are required

Challenge 5:
Towards this end, there has been growing interest in expanding spectroscopic methods beyond the 2 μm range of the infrared spectrum and up to the 12 μm wavelength. Unfortunately, water itself is a very strong absorber of infrared light. Thus, since available infrared light sources provide only insufficient power, comparable methods are restricted to strongly confined laboratory settings



Photodetectors by VIGO System S.A.

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

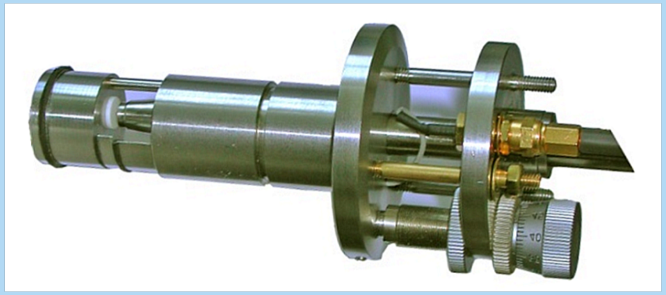
- WaterSpy develops water quality analysis photonics technology suitable for inline field measurements operating in the mid-infrared region (6-10 μm)

- The solution is based on the combined use of advanced Quantum Cascade Lasers employing the Vernier effect and novel, fibre-coupled, 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 30-45 minutes for a full sample analysis of 250 mL. 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



Commercial ATR probe and custom-built ultrasound accessory.

[Ultrasound-Enhanced Attenuated Total Reflection Mid-infrared Spectroscopy In-Line Probe: Acquisition of Cell Spectra in a Bioreactor,
Analytical Chemistry 2015 87 (4), 2314-2320]

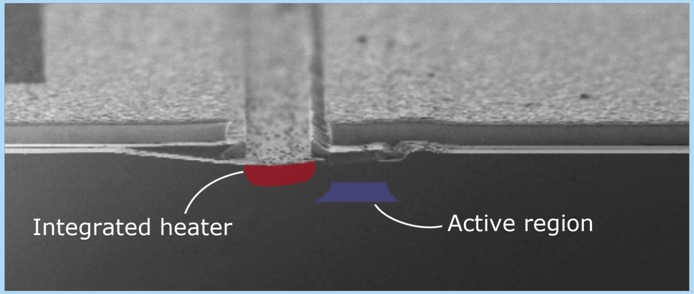
WaterSpy Pilot Sites

Pilot 1: Prato Water Treatment Plant
The Prato Water Treatment Plant serves the city of Genova (Italy), which has approximately 580.000 inhabitants. The Prato plant has an average flow rate of about 80.000 L/min. It receives raw water from two different sources: the Brugneto Reservoir and the Bisagno River

The duration of the pilot will be 3 months. During this period, samples will be analysed by the WaterSpy device every 30-45 minutes. In parallel, samples will be collected manually and will be analysed in the lab. In this way, results will be verified.

Pilot 2: Genova Water Distribution Network
The second validation site will be the entry point to the water distribution network of Genova, just downhill the Prato Water Treatment Plant. In this way, it will be possible to evaluate also the efficiency of the water treatment train of the plant. The treatment train includes pre-disinfection with chlorine dioxide, coagulation/flocculation, filtration through sand media and secondary disinfection with chlorine dioxide.

Any momentary break in the treatment chain could allow substantial levels of microorganisms to enter the final potable water. WaterSpy's high sensitivity and quick response time would bring a step change in such applications.



Buried laser with the integrated semiconductor heater.

[Extended tuning of mid-ir quantum cascade lasers using integrated resistive heaters, Opt. Express 23, 29715-29722 (2015)]