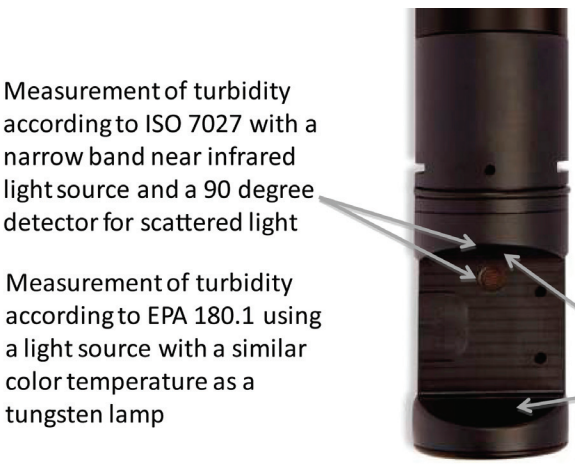
Low Cost Water Quality Monitoring for Multiple Parameters

It is a common sense today that real-time water quality monitoring is vital to efficiently operate water plants and manage sources. Still, some operators have concerns about the reliability and maintenance needs of such sensors, as well as the costs involved. Maybe a final answer to this concern is the i::scan, a new, very affordable miniature spectrophotometer that can measure multiple parameters in real-time. It can be used in almost all water monitoring applications, for treatment control, and for industrial processes.



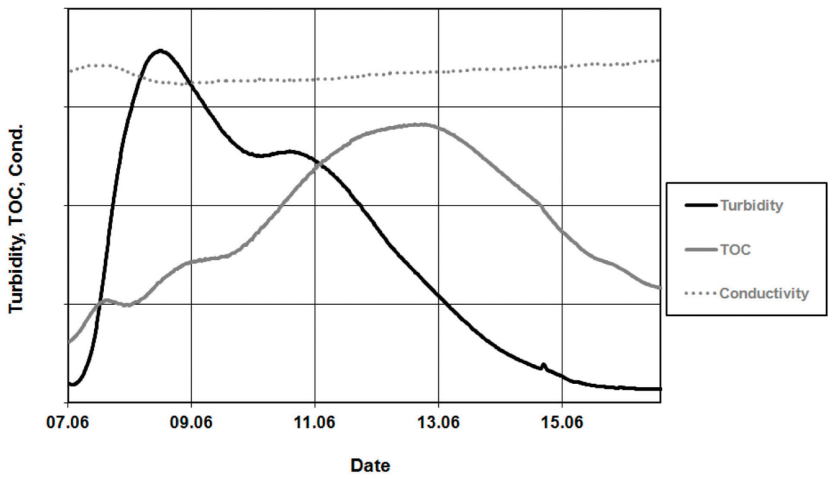


Figure 1: The typical effect of effect of heavy rainfall on river water

"The i::scan belongs in all of our UV-C systems. Measuring SAC-254 and turbidity simultaneously will set new standards in water quality monitoring." Alejandro Schnyder*, CEO of Aqua Innovation

*Manufacturer of UV disinfection systems. Deployed several nano::stations and in-pipe i::scans in UV disinfection systems

s::can first introduced spectrometer probes for water quality monitoring back in 2000, and, having sold close to 5000 of those systems worldwide, is the market leader. However, it became evident that in many applications, the extreme spectral resolution of the high end "spectro::lyser" is not needed, and costs of around 10.000€ are often restrictive for water plants serving <10,000 people, and in less developed countries. s::can's target has always been to make spectrometry a really affordable method: Today, the i::scan can be offered at the price of a good turbidity meter.

How does it work

The i::scan was designed around a miniature array of light emitting diodes (LEDs) as the light source. LEDs have many advantages over traditional light sources, as they are reliable, stable, small, and have low power consumption. The emitted light spectrum ranges from 250 to 860nm, at low resolution.

Advanced optics allow the combination of a 180° spectral absorption measurement with a 90° light scatter measurement in a single instrument. This means that turbidity can be measured according to the ISO 7027 - 860nm - and EPA 180.1 - white light - standard.

The selection of the appropriate wavelength ranges have been optimised for measurement of popular water quality parameters in many types of applications. The algorithms for calculation of the parameters were designed based on the well proven algorithms that are used in s::can's high end spectrometer probes.

The i::scan is extremely robust, using a high-tech polymer (PEEK), sapphire windows, and very resistant sealings. It can be exposed to any challenging waters including sea water. Due to the low power consumption, it can be powered by solar panels or batteries.

Combined Turbidity and Organics in One Device

"Organic carbons" play an important role for evaluation of water quality. Parameters like COD or DOC picture an important portion of the matrix with respect to organic substrate, nutrition, pollution, and treatability. In many cases, the interesting portion of the organics will be present in the dissolved form, thus invisible for a turbidity sensor. A spectrometric DOC sensor like the i::scan, however, responds to most of these organics, from waste water to finished drinking water.

As shown in figure 1, the effect of heavy rainfall on spring water is elevated turbidity followed by elevated TOC, while no significant change in conductivity was observed.

Reason for the popularity of light-scattering based turbidity sensors is not the diagnostic value of the parameter, but mainly cost limitations. The

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much more important dissolved and non dissolved organic parameters have not been affordable to be monitored, until today. All this leads to the conclusion that a good monitoring system should combine both organics and turbidity, if only affordable.

i::scan Installation & Cleaning options

There are three different installation options: The i::scan can be mounted submersed in the water, or in a flow cell (bypass installation), or directly in a pipeline of almost any diameter. For latter, there are two different fixtures available: A simple version (fig 2., left) for smaller diameters, and a "hot-tappable" version (fig. 2, right) for large mains pipes. The hot-tappable fixture contains a shut off valve, which enables to remove the sensor for maintenance without interfering with the pipe flow, and a drainage pipe that can also be used to connect an acoustic "spy" for leak detection.

Figure 2: The i::scan can be mounted directly in a mains/pressure pipe

Depending on the water quality, the measurement windows of the i::scan need to be cleaned from time to time. This can be done automatically by either connecting pressurised air (in waste water) or via a rotating brush (in clean waters). By doing this, the i::scan can be operated drift free for many months.

i::scan References

For the last 18 months, 100 i::scans were tested in all kinds of applications world wide. Testing sites include drinking water, river water, and waste water applications, from extreme environments like the pacific Island of Saipan (10 installations) to utilities in Austria, Switzerland, Italy, Netherlands, USA, etc. In each single one of these field tests, the i::scan has proven its excellent functionality, stability, accuracy, and reliability. One example is the installation in Cincinnati, OH. GCWW is one of the most innovative and quality fanatic water utilities in the USA. Because of the proven stability and accuracy observed, they ordered several nano::stations including i::scans immediately after the test.

Zurich waterworks supplies one of the world's best quality drinking water to the region's consumers. To prove that the quality of the water remains pristine all over the network, and to detect any potential deterioration of quality in real-time, they have been testing water quality monitoring solutions that can be deployed in-pipe and are accurate and cost effective at the same time. The i::scan showed to be the perfect solution and is used to measure turbidity, UV254, colour and TOC.

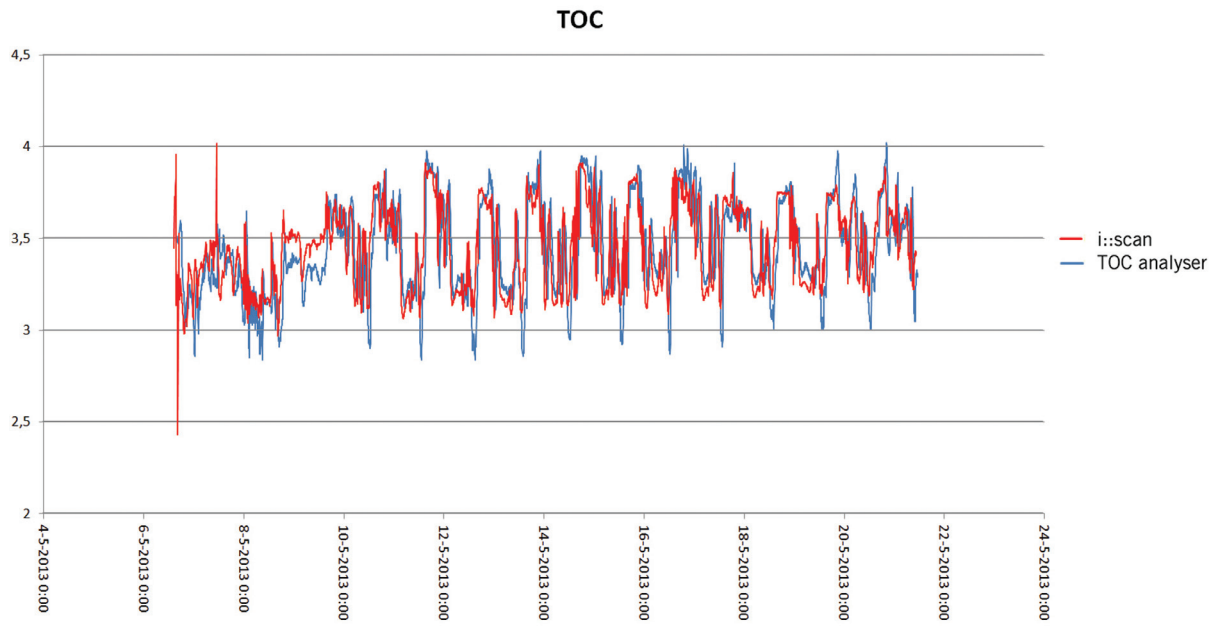

Figure 3: Measurement results of the i::scan absolutely keep up with those of traditional TOC analysers that cost 5 times more and requires high maintenance.

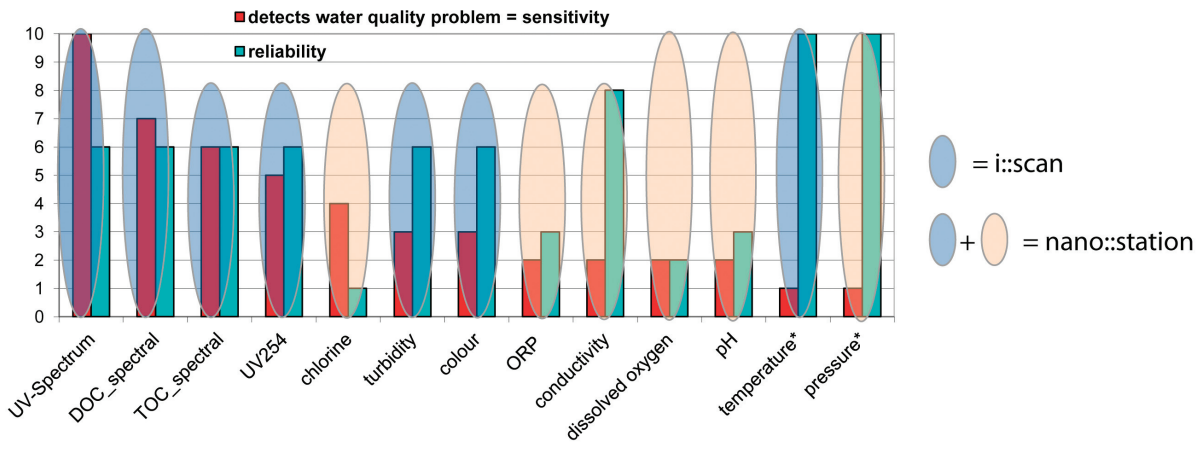

Figure 4: Comparison of the sensitivity and the reliability of different water quality parameters

Smart Water Quality Grids

The i::scan is the ideal device for multi-point water quality networks. In such environments it can be directly connected to any kind of SCADA network, data loggers, or other devices via RS485, or, coming soon, via the internal I.P. and web server to the cloud or smart phones.

Vitens is the largest water utility company in the Netherlands, and well known for their innovation culture. They have successfully tested the i::scan, and are going to install a grid of them as a part of a EU funded demonstration project.

"The installation of a grid of water quality sensors will allow us to actively manage our water supply distribution networks based on real time status data." Says Erik Driessen, innovation manager of Vitens.

The nano::station completes the range of parameters

In drinking water network monitoring, the traditionally measured parameters are Chlorine (Free and/or Total), Turbidity, pH, and conductivity. Chlorine is typically to be reported, while the others are to give an overall picture of water quality and eventual problems. With the i::scan, the much more interesting TOC can be added at a small additional cost, and the additional information's value is enormous.

All sensors come in one 4-channel flow cell, mounted on a panel at a fraction of size compared to conventional analysers. The installation and start-up is plug-and-measure. Maintenance, and with this OPEX, is close to zero. With this, the nano::station represents a totally new approach to distribution network monitoring.

Figure 5: The nano::station combines the i::scan with additional sensors for pH, chlorine and conductivity.