www.s-can.at

s::can
Intelligent. Optical. Online.

Real-Time Water Quality Monitoring Systems: UV-Vis Spectrometry and The Vienna Experience (Part 2)

Real-Time Water Quality Monitoring Workshop
St. John's, June 16th and 17th, 2009

© s::can Messtechnik

s::can
Intelligent. Optical. Online.

s::can Online Spectrometers – for Almost Every Application

0.5-5mm (waste water)

+ waste water: ppm to g/l

+ sewer system

+ processes / industries

- paper
- vine
- beer
- juices
- oils
- petrochemical
- biotech
- ……..

35 mm (sensitive)

+ general water monitoring: ppb to ppm

- river water, bank filtrate
- sea water
- groundwater, -recharge
- drinking waters
- compliance of WWTP
- treatment processes

+ alarm / early warning systems

100 mm (ultra sensitive)

+ water monitoring: low ppb

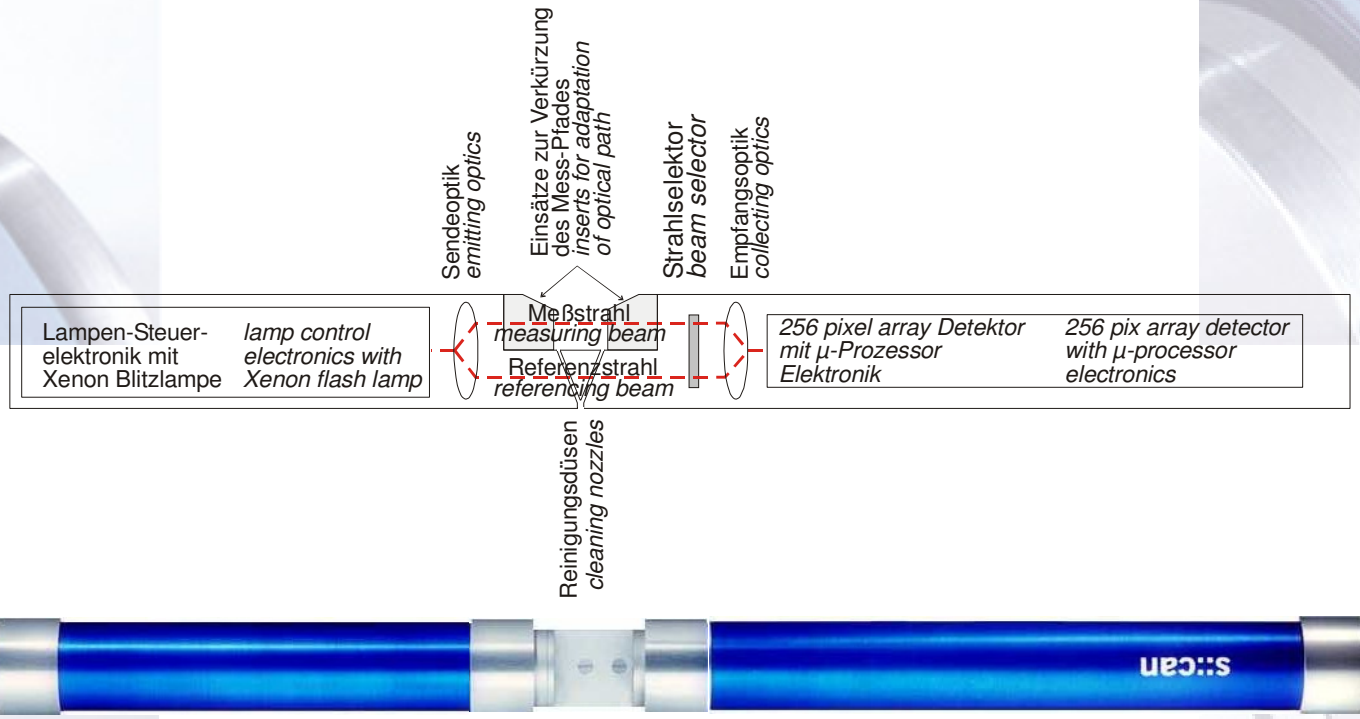
- drinking waters: alarm + protection / security / distribution system
- ground waters (organic contamination)
- sea water
- low turbid drinking waters
- ultra pure waters

+ processes / industries

- cooling waters
- pharma
- electronics industries

© s::can Messtechnik

s::can Online Spectrometer – How Does It Work



© s::can Messtechnik

Online Spectrometry - Introduction

- **For concentrations ranging from ppb (drinking waters) up to g/L (industrial waster waters), UV-Vis spectrometry has established as a leading method for in-situ concentration monitoring of:**
  - Nitrate and nitrite (far superior to ISE)
  - Turbidity and / or suspended solids (NTU_eq, FTU_eq, TSS)
  - Organic parameters (UV254, COD_eq, TOC_eq, DOC_eq)
  - Process specific parameters
  - Water quality changes, alarms, event detection (EDS)
- **Some more specific parameters are (amongst others):**
  - B, T, X; Phenols
  - Hydrocarbon Alarm
  - H2S
  - Ozone
  - and many more

© s::can Messtechnik

s::can
Intelligent. Optical. Online.

Online Spectrometry - Introduction

- there is absolutely no wear
- there is absolutely no instrument drift because of 2-beam system
- the only two issues to care for is: 1) good installation 2) keep windows clean (several auto-cleaning options)
- we recommend one zero check per year, but many instruments are never set zero during many years of operation
- big difference to any other online sensor: It does NOT loose its calibration, and no re-calibration necessary after eventual initial local calibration ….
- except the water completely changes its characteristics - which can be the case in waste waters, but not in river waters.
- if probe does not agree enough with lab (or other way round), this is very rarely a problem of calibration but of a) installation b) windows not clean c) reference procedure d) technical fault

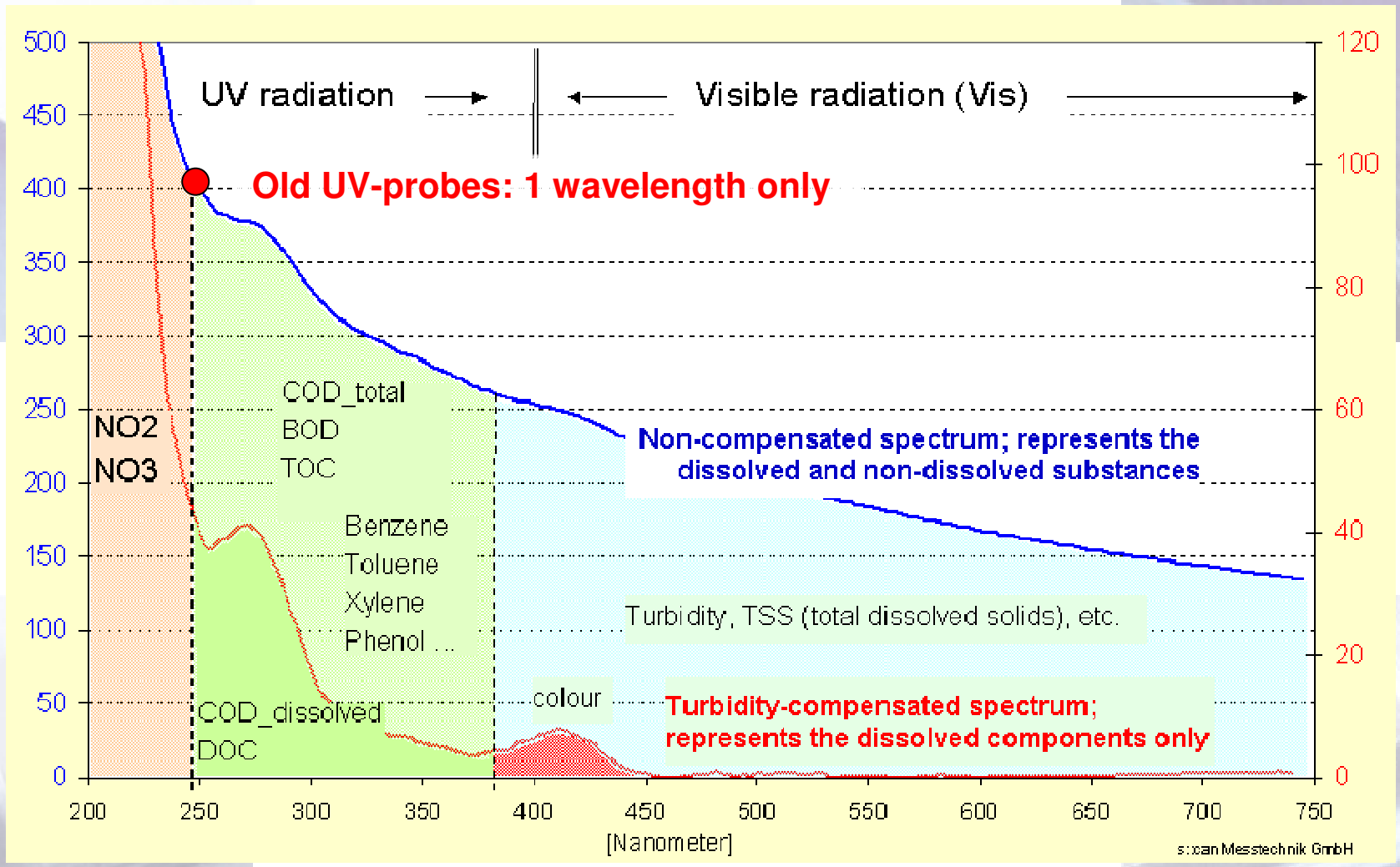
© s::can Messtechnik

s::can
Intelligent. Optical. Online.

Online Spectrometry - Introduction

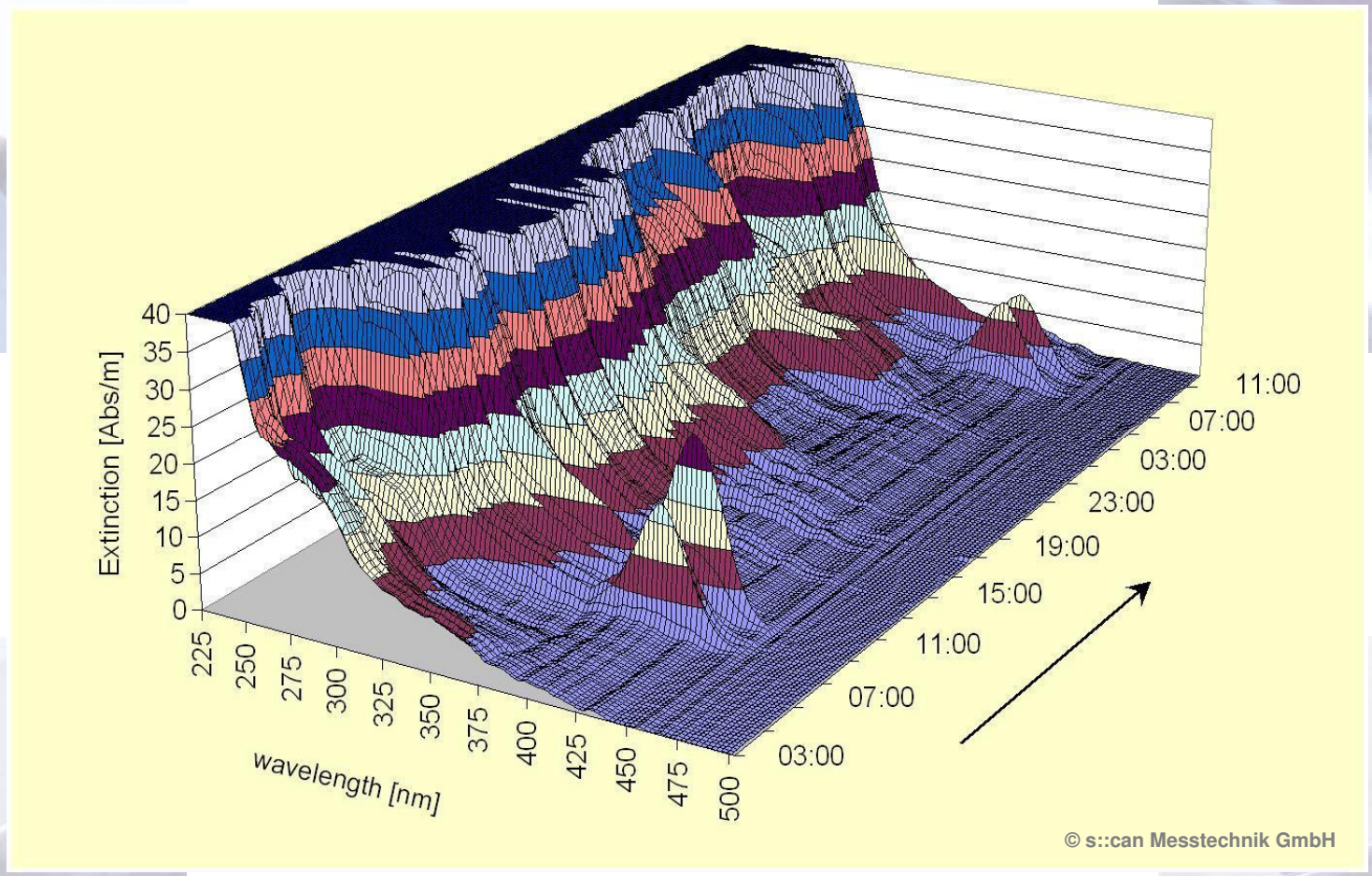
- **UV-Vis Spectrometry makes use of the wavelength-specific light absorption caused by (groups of) substances.**
- **Simple principle:** Nitrate is just another (invisible) color. If our eyes were sensitive in the UV, we could “see” Nitrate and distinguish it i.e. from Nitrite, like we distinguish any other colors ! (But UV would destroy our eyes).
- **Not all organics and ions absorb light, but many.** Estimate is that 60 to 80 % of the organics measurably absorb light.
- **s::can spectrometer probes represent today’s most simple and natural way of any to monitor the composition of water.** Simpler than a pH sensor.
- **No chemicals, no reagents, no membranes, no wear, no moving parts in the water, most tolerant installation, low power consumption, etc.**
- **One year of unattended operation feasible.** Just keep windows clean / auto-clean / and nothing else to take care for.

© s::can Messtechnik

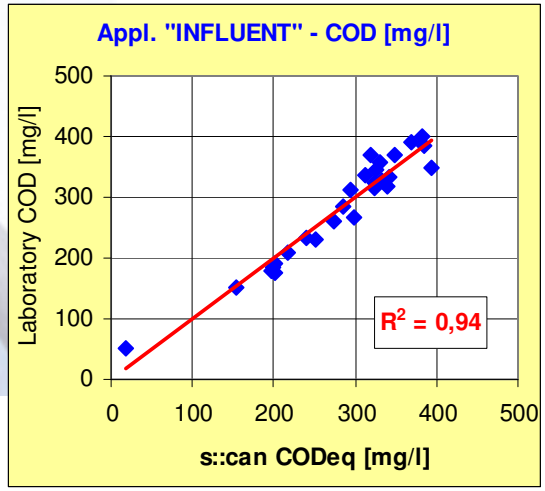


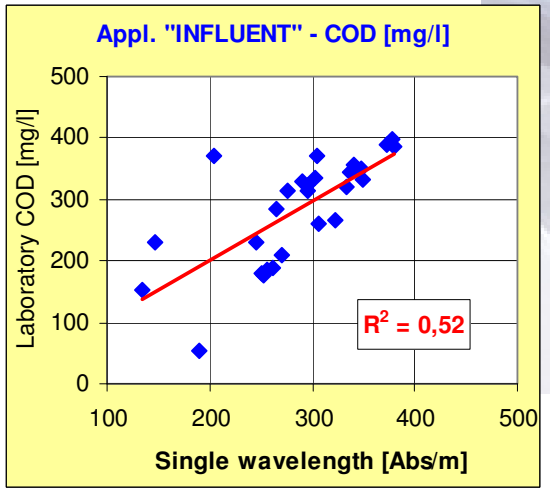
© s::can Messtechnik

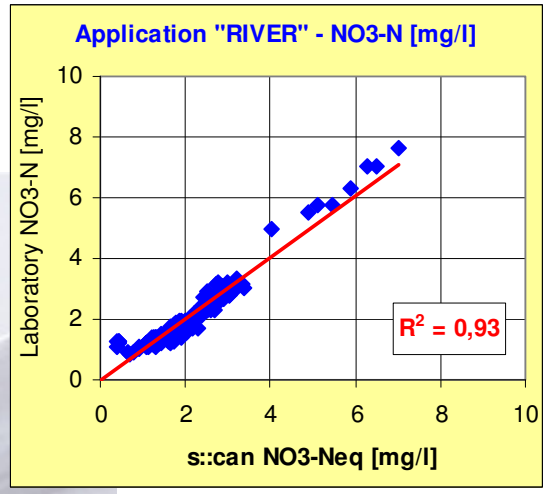
Online Water Quality Monitoring & UV/Vis Spectrometry

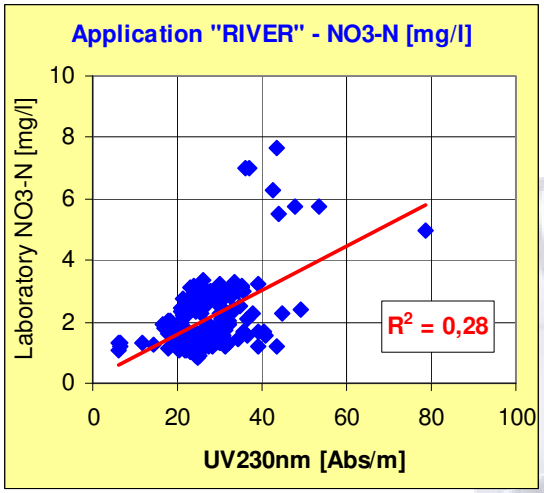


Why is Spectrometry Better than Single Wavelength ?



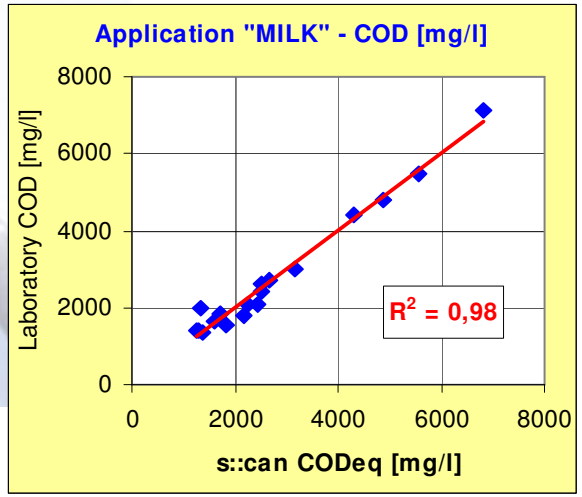


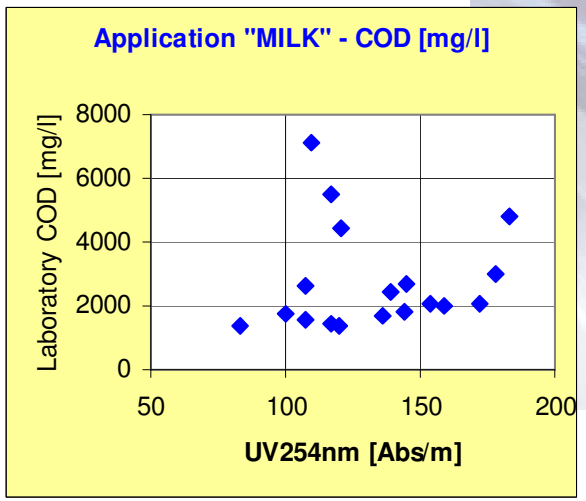


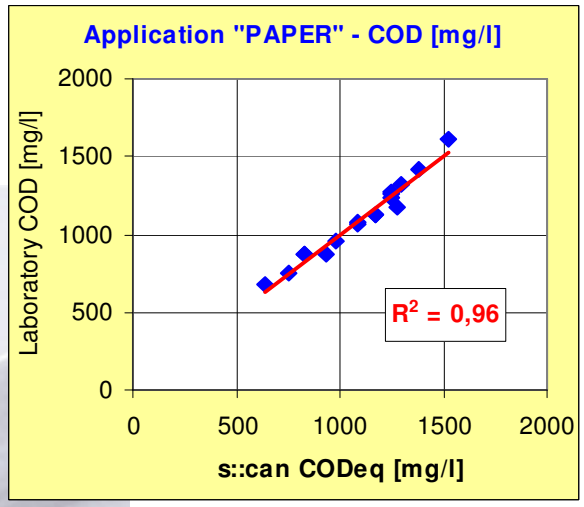


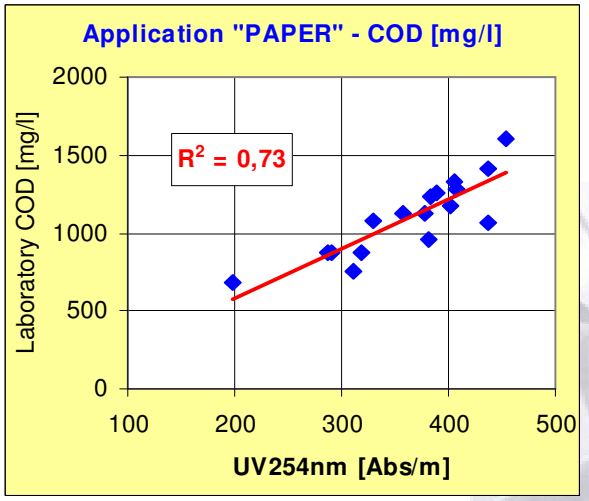
© s::can Messtechnik

Why is Spectrometry Better than Single Wavelength ?



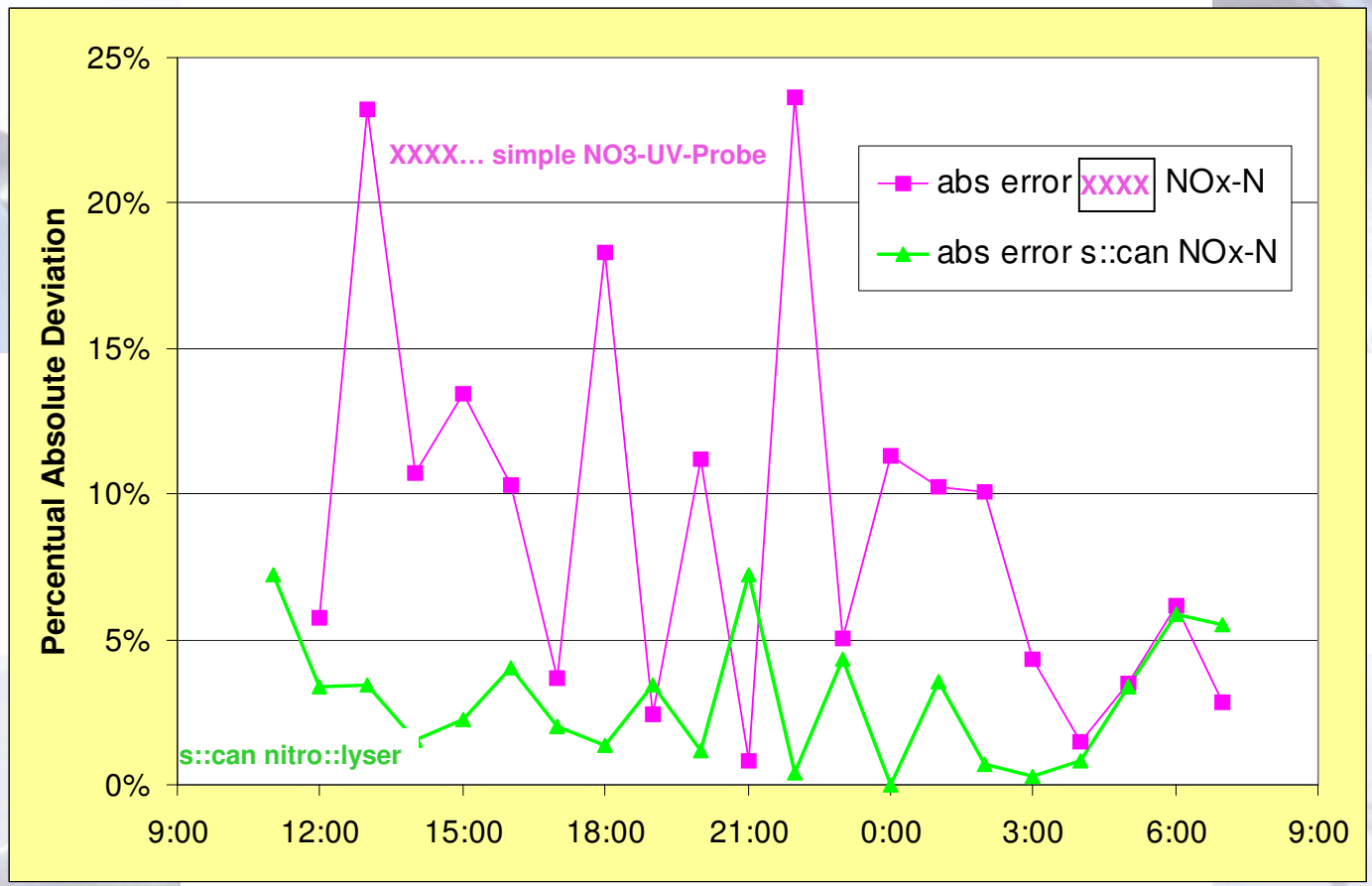






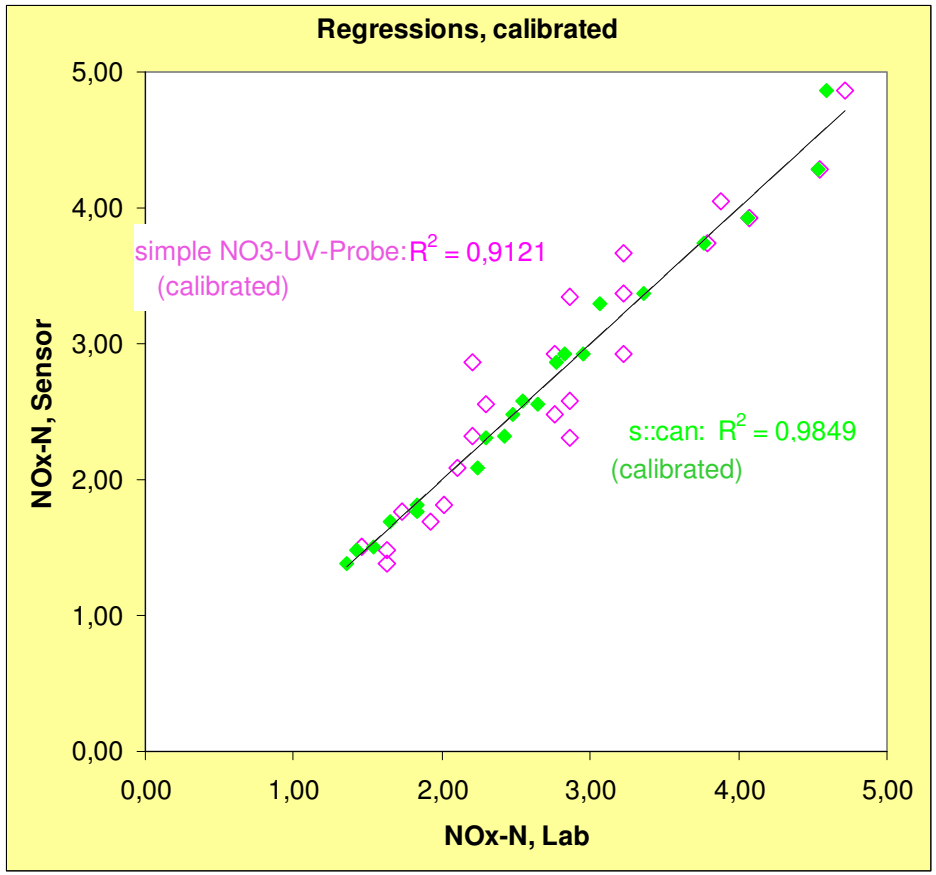
© s::can Messtechnik

Why is Spectrometry Better than Single Wavelength ?

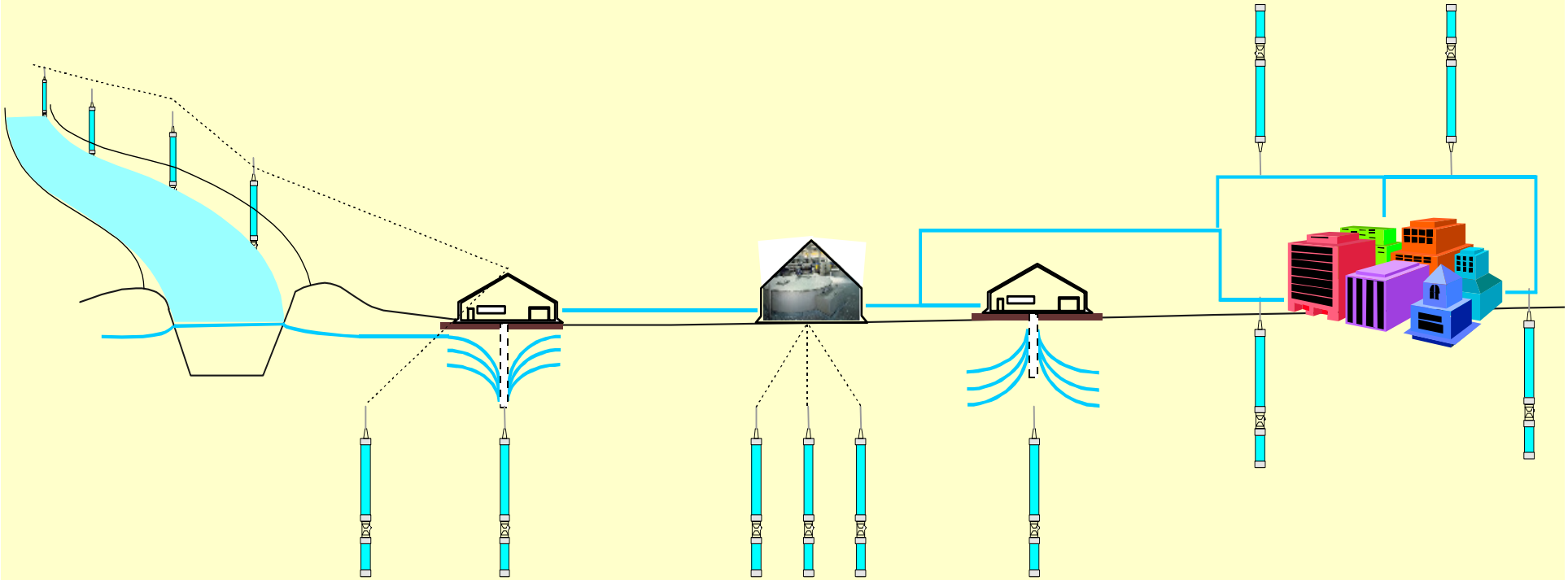


© s::can Messtechnik

Why is Spectrometry Better than Single Wavelength ?



© s::can Messtechnik



Fließgewässer-überwachung:
- $SAK_{254\ (280,\ 436\ etc.)}$
- DOC_eq
- Nitrat_eq
- KW_eq
- Trübung
- Alarmsysteme
- Frühwarnsysteme

Überwachung der Uferpassage
- Filterwirksamkeit
- Überwachung der Trübe incl. Feintrübe/Kolloide
- Alarm bei spezifischen und unspezifischen Überschreitungen
- DOC_eq.
- Nitrat_eq.
- KW_eq.

Brunnen überwachung
- Grundsätzliche Eignung zur Trinkwassergewinnung
- Trübung
- Alarm
- DOC_eq
- Nitrat_eq
- KW_eq

Überwachung, Betrieb und Steuerung der Aufbereitungsanlage
- Trübung
- DOC_eq.
- Ozon
- Veränderungen des OC bei der Oxidation
- Oxidations-Folgeprodukte
- Filtereffizienz/-durchbruch
- Adsorption/-durchbruch
- Flockung / Trüb. / OC
- Nitrat_eq.
- div. Einzelsubstanzen
- spektrale Überwachung

Überwachung, Betrieb und Steuerung der Grundwasser-anreicherungsanlage:
- Trübung
- DOC_eq
- Nitrat_eq
- Einzelsubstanzen_Alarm
- qualit. spektrale Kontrolle

Überwachung des Verteilnetzes:
DOC_eq.
Nitrate_eq.
Trübung
hygienisches Risiko
Einzelsubstanzen_Alarm

"Eignung von Rohwasser zur Gewinnung von Trinkwasser"

s::can
Intelligent. Optical. Online.

Water in Vienna

Brief history of Vienna and its Water

Vienna Area Urban Settlement since Roman Times

- First start of modern distribution network in the 16th century, and first modern sewers in the 17th century
- As center of the Austro-Hungarian empire Vienna grew from 270.000 to > 2.100.000 inhabitants in 1800 – 1910
- To ensure water supply new infrastructure was needed – realised in the form of 2 aquaducts between 1873 & 1910
- Water supply and treatment still being expanded and modernised

s::can
Intelligent. Optical. Online.

Water in Vienna

- Main source for Drinking Water are mountain springs in carstic rock formations
- The water from individual sources is collected and transported to the city using two aqueducts (over 280 km)
- A number of back-up sources has be established, but spring water is still the main supply
- Water is used without any purification other than sometimes little chlorine (no residual at tap)
- Important: carstic water sources are sensitive to extreme weather conditions, heavy rainfall can affect water quality

- online control of sources is necessary to ensure continuous high quality water

© s::can Messtechnik

Vienna‘s Drinking Water Supply System

© s::can Messtechnik

s::can
Intelligent. Optical. Online.

Monitoring at Vienna Waterworks

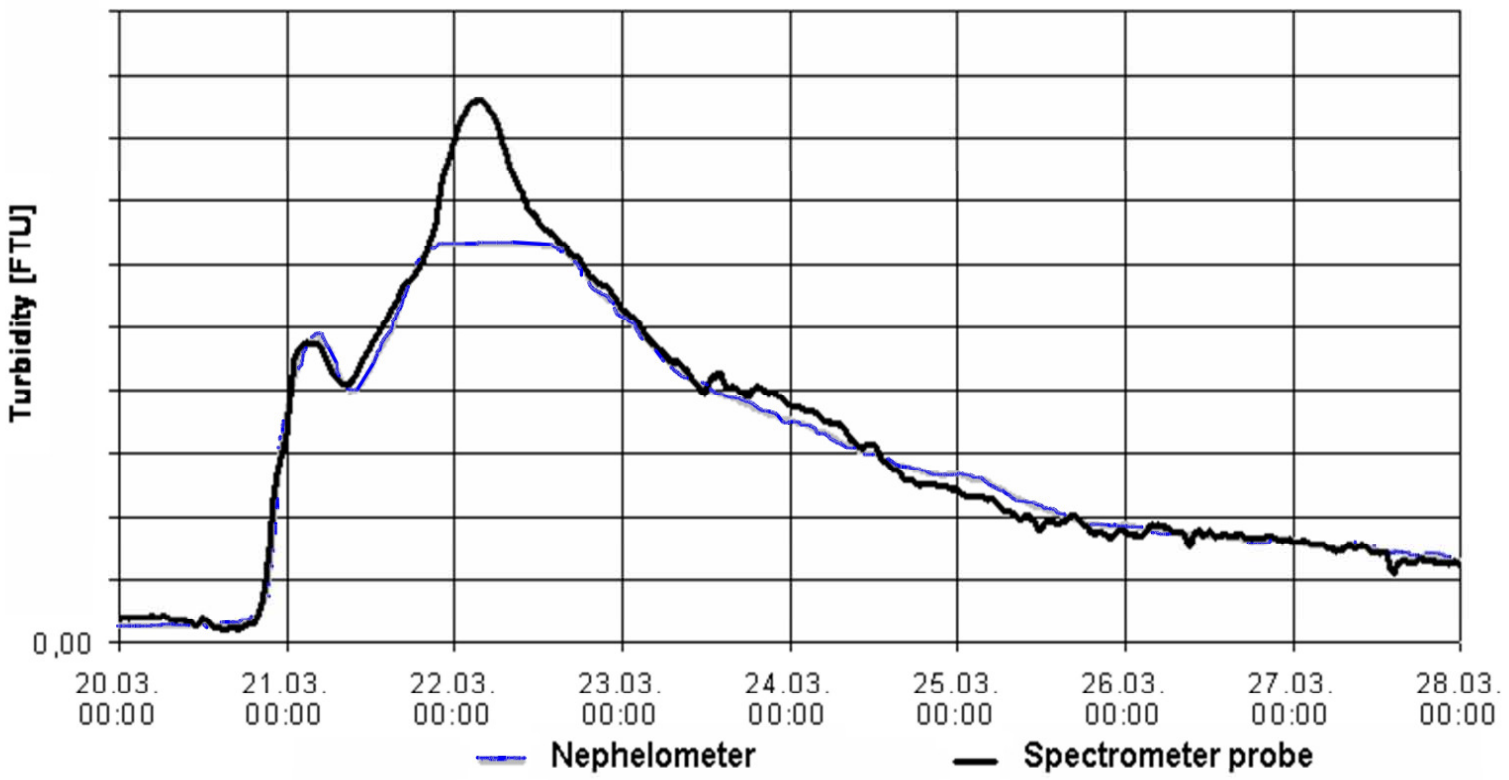
- Until 2001, only a small number of major springs monitored online
- mainly physical parameters & SAC254
- expensive stations
- Since 2001, a network of > 30 stations including spectrometer probes, pH, and conductivity established by s::can
- Data collected by central network and accessible from 3 control stations
- Many springs in remote locations -
  no infrastructure apart from mains power

For commissioning

- Multi Instrument inter-comparison verifications crucial before service acceptance of multiple probes
- Inter-comparison with other measurement techniques (turbidity, SAC254) performed

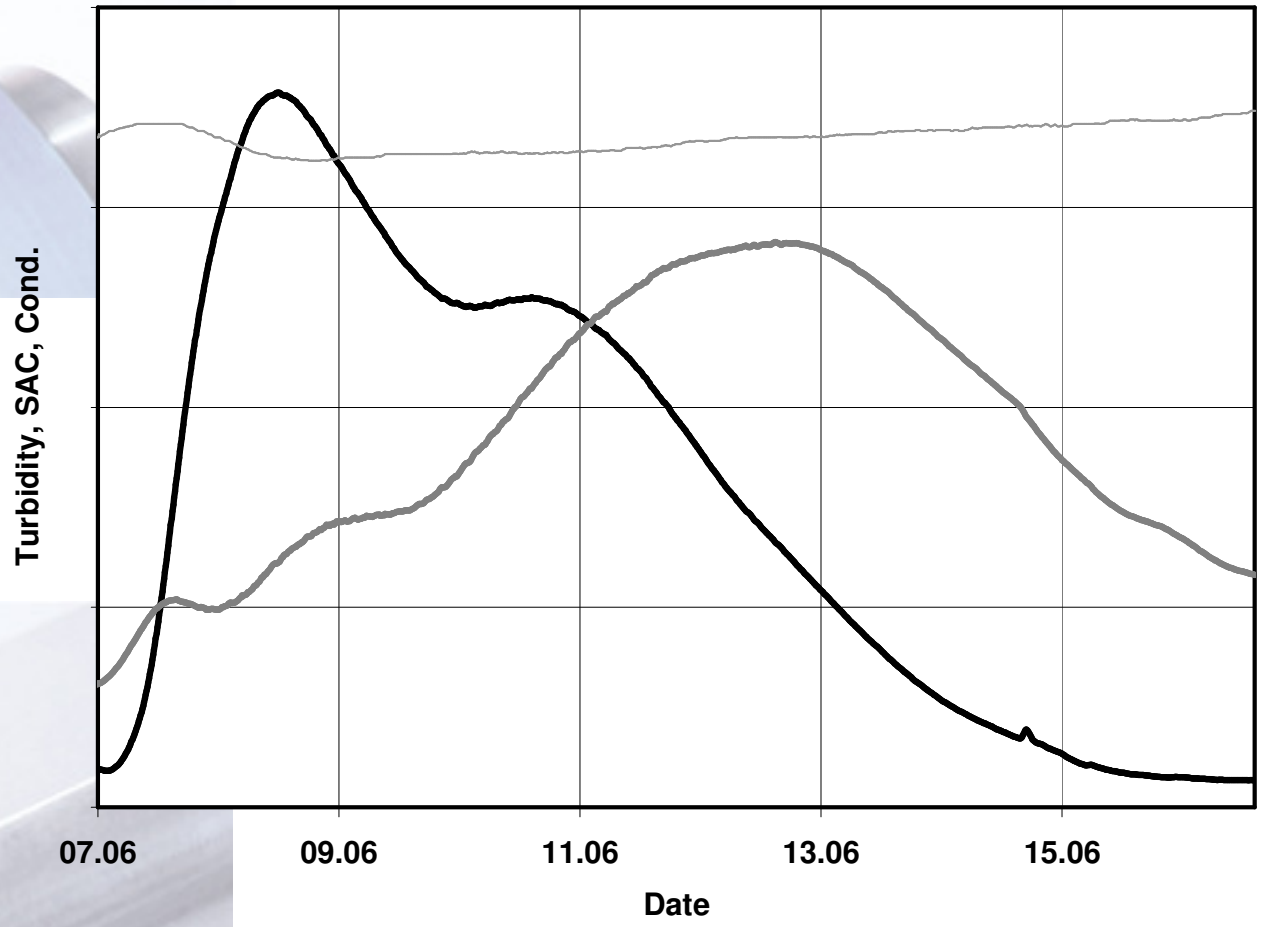
Vienna Drinking Water

Testing:



© s::can Messtechnik

Vienna Drinking Water



Real-Time Water Quality Monitoring: The Vienna Experience

© s::can Messtechnik

Into Vienna‘s Sewer System

In total 2200 km of sewer draining 260 km²

Issues

- water quality monitoring
- corrosion control and odour management

Operational challenges

- highly variable flow conditions
- mechanical damage
- corrosion
- explosive atmosphere

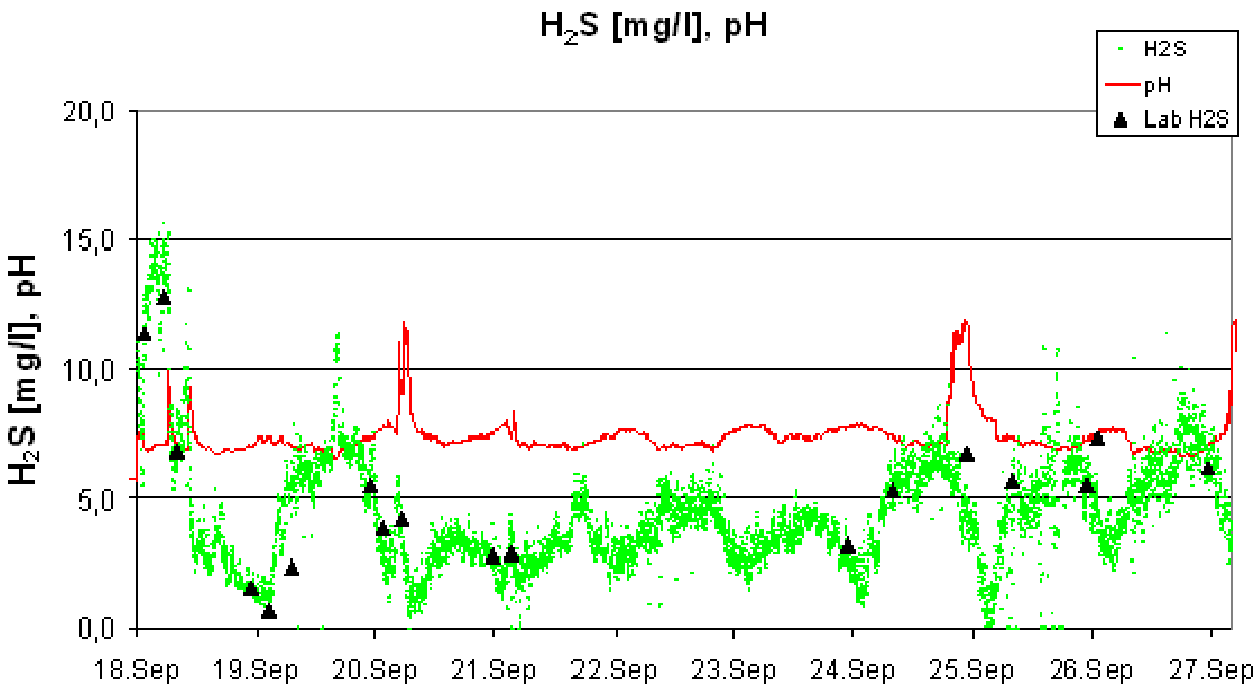
© s::can Messtechnik

Sewers applications

Corrosion and Odour control – Hydrogen Sulphide

Two methods:

- nitrate measurement
- sulphide measurement (UV + pH)



© s::can Messtechnik

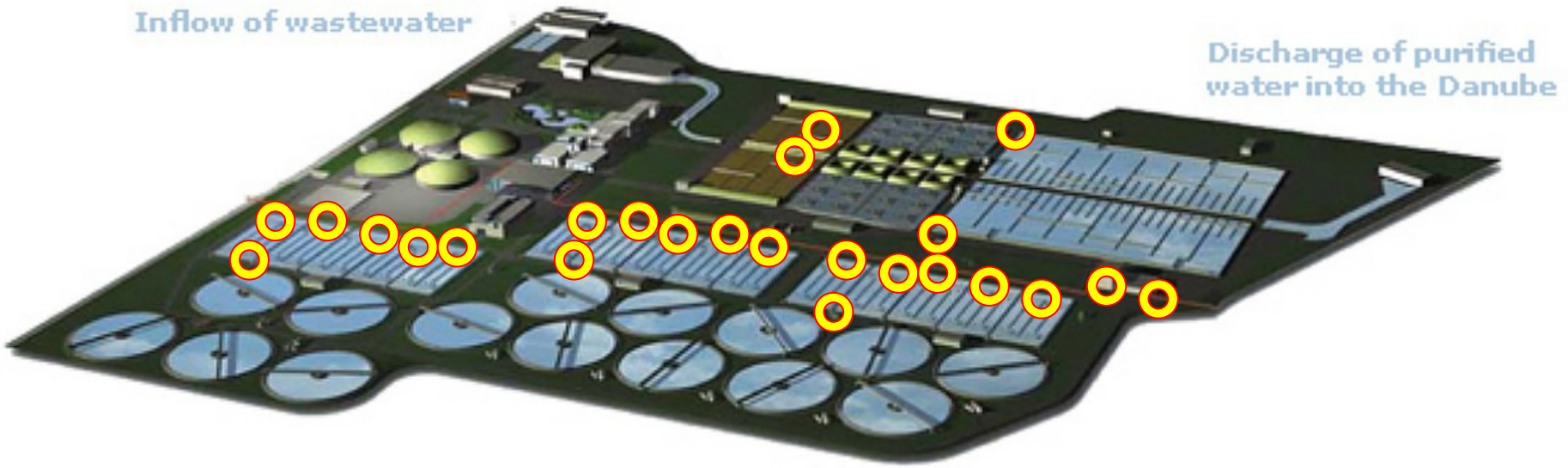
www.s-can.at

s::can
Intelligent. Optical. Online.

Vienna Waste Water Treatment Plant

Main treatment plant:

- responsible for 4 million person eq.
- can treat 680 000 m^3 / day
- expanded and modernised in 2003 - 2005



s::can
Intelligent. Optical. Online.

WWTP applications

Spectrometery at the WWTP

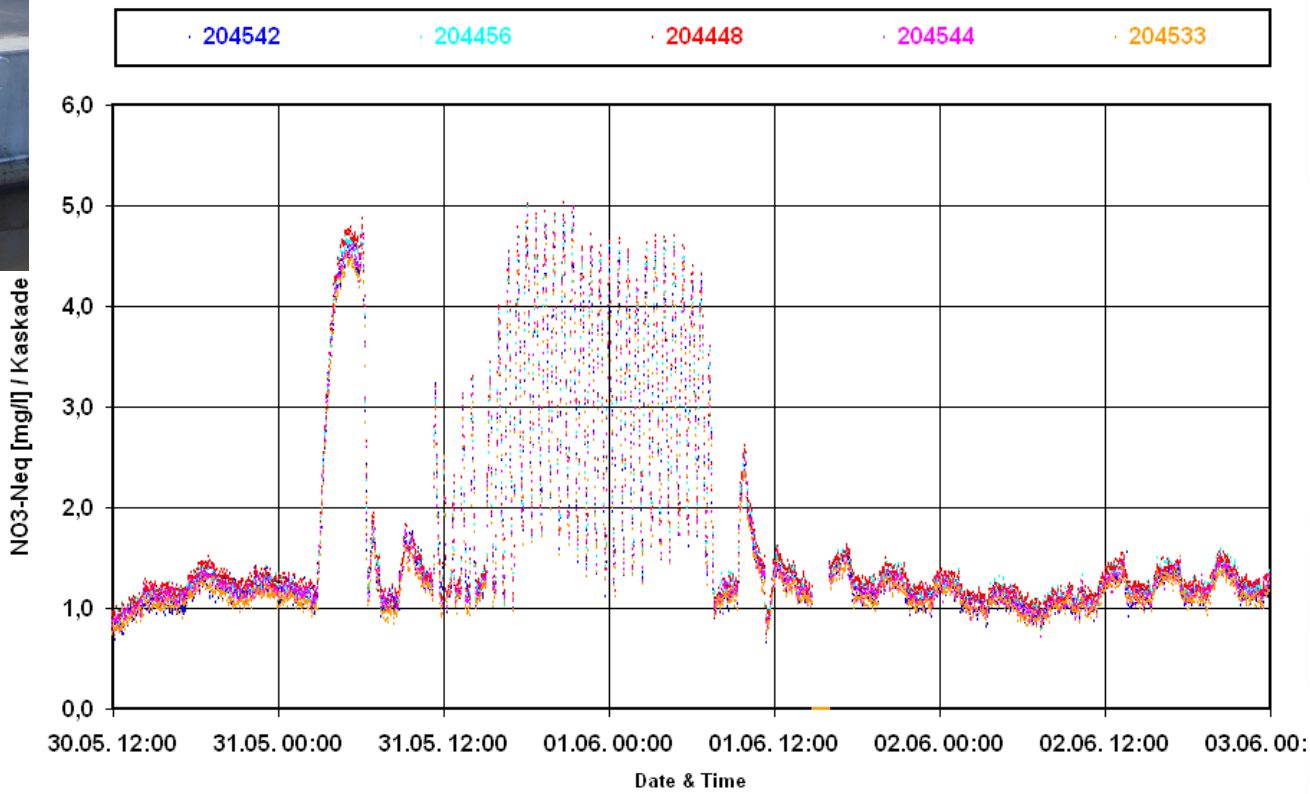
30 Instruments used for:

- measurement of COD, NO3 and TSS in plant Influent
- TSS and NO3 in primary and secondary aeration basins
- control of sludge recycling by nitrogen measurement in secondary aeration
- special algorithm used to measure NO3 without cross-sensitivity to Iron Chloride
- Using pressure air cleaning, no regular maintenance is required, apart from periodical visual inspection and trivial cleaning of optical surfaces

WWTP applications

Spectrometery at the WWTP

avg difference between probes: < 0.8% or 0.17 mg/L

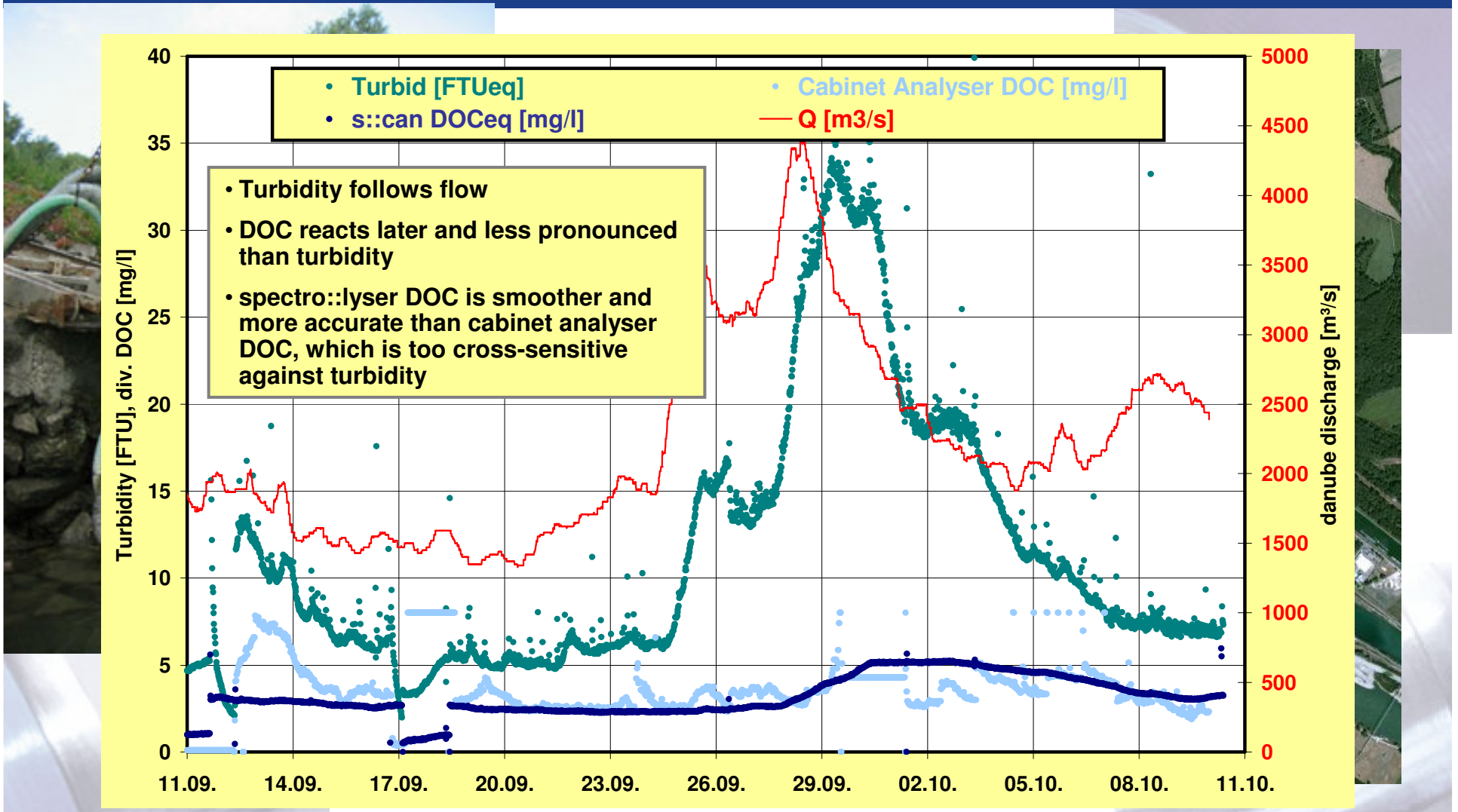


© s::can Messtechnik

The Danube – river water monitoring

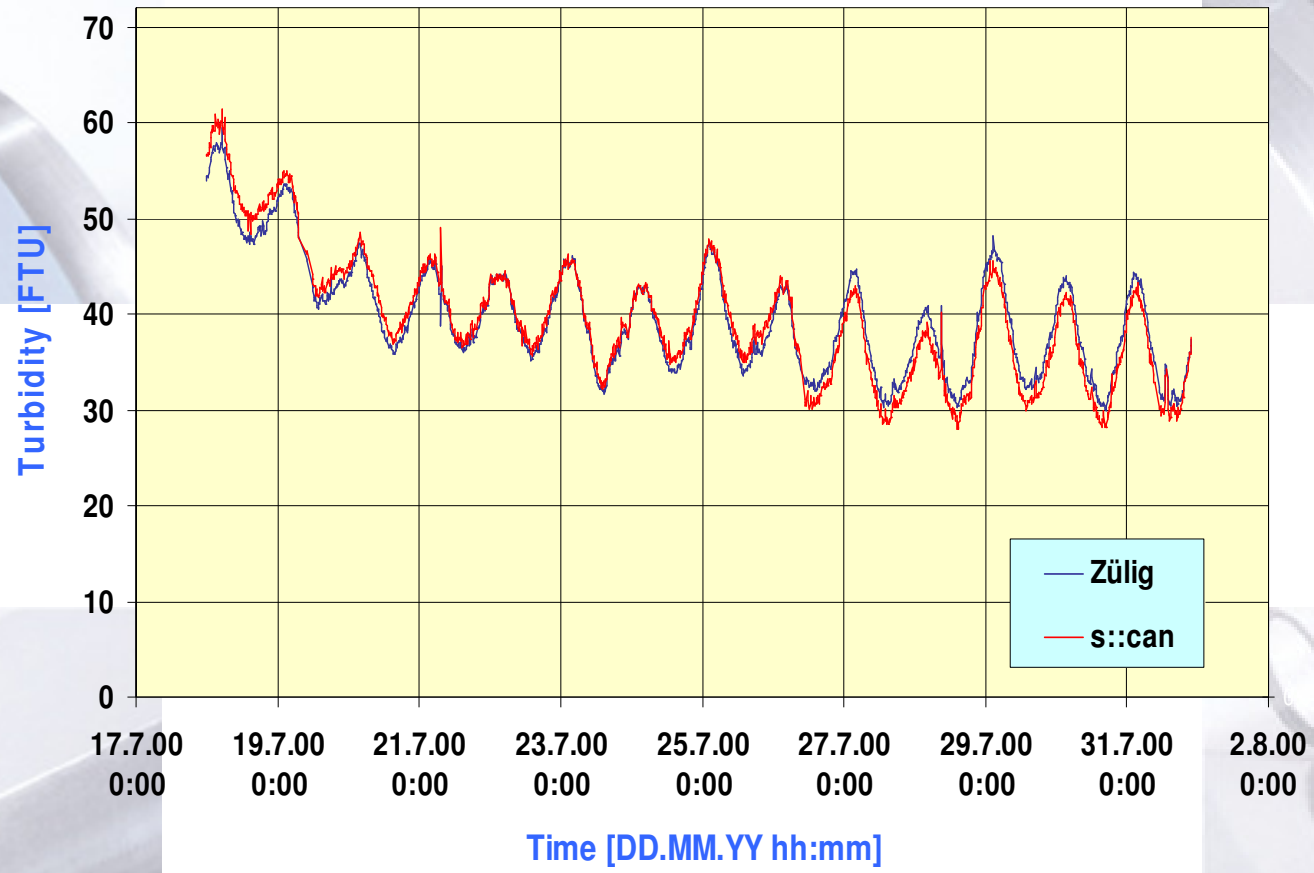
© s::can Messtechnik

The Danube – river water monitoring



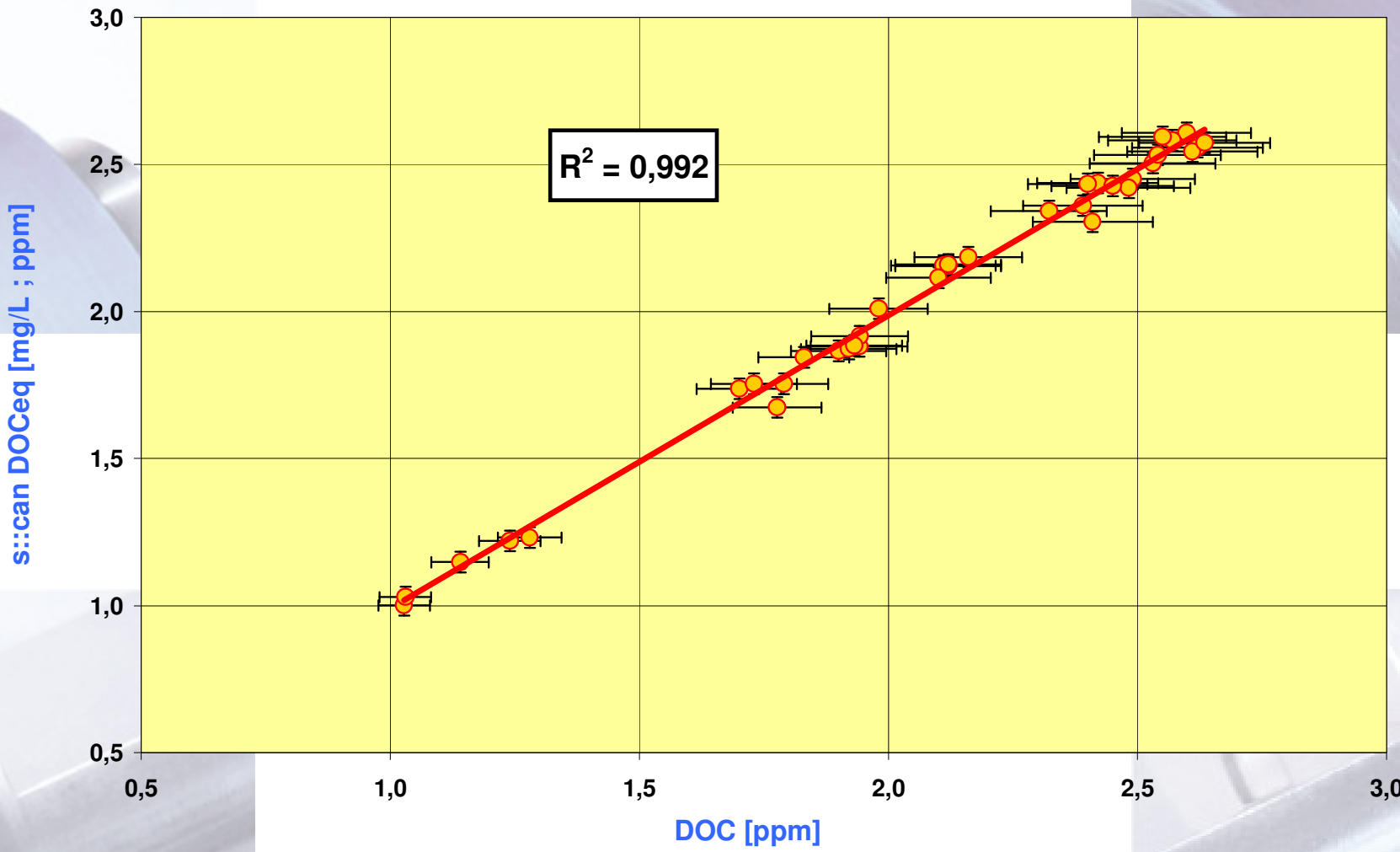
© s::can Messtechnik

The Danube – river water monitoring



© s::can Messtechnik

The Danube – river water monitoring



© s::can Messtechnik

s::can
Intelligent. Optical. Online.

Groundwater Recharge

New hydropower plant built by VERBUND – Austrian Hydro Power AG

Sealing wall constructed to prevent excessive infiltration of surface water

This reduces the natural dynamics of the ground water, which is actively compesated by:

- artificial recharge with bank filtrate water
- tranfer from infiltration wells back to the Danube

- transfer of water is stopped in case of bad quality

Six monitoring stations have been built to safeguard the water hydrodynamically affected by the power plant.

s::can
Intelligent. Optical. Online.

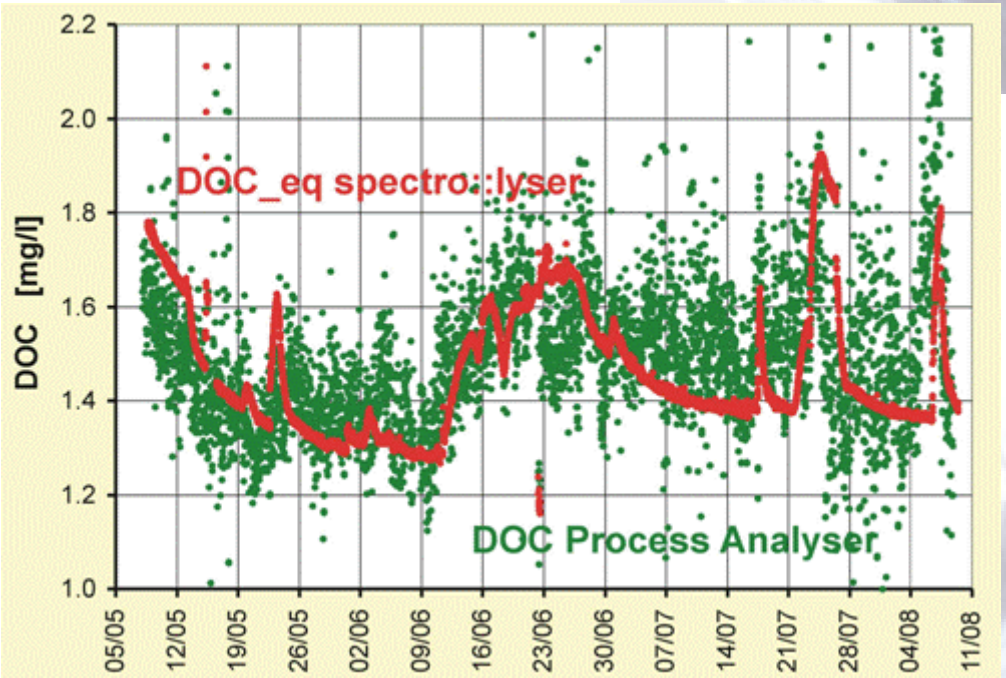
Bank filtrate monitoring

- **In this application the spectrometer probes are used for monitoring the composition of the bank filtrate water**
- **DOC by UV absorption is used as the control parameter**

Long term tests have shown:

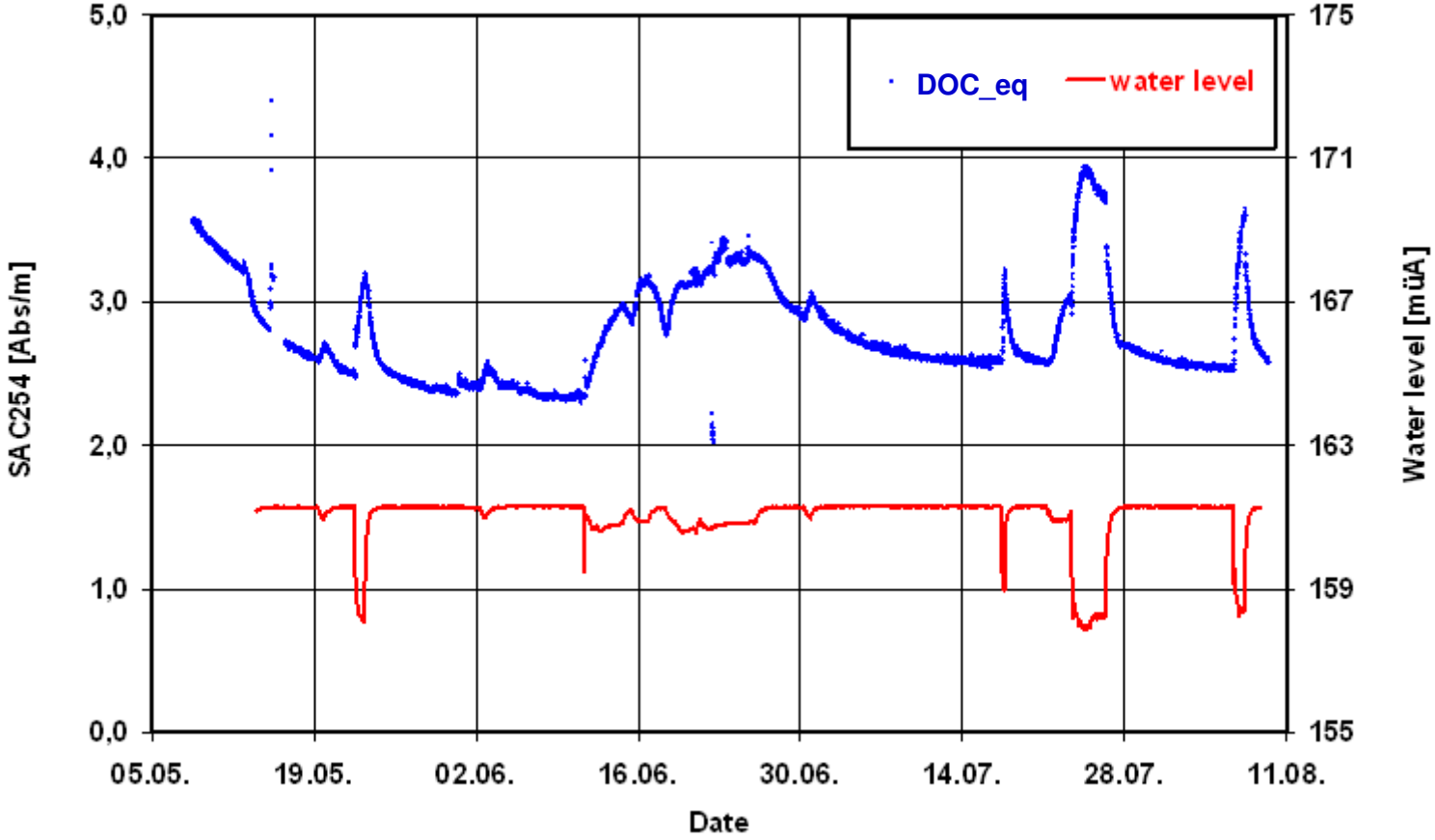
- high availability of the instruments
- precision of measurements much higher than with TOC analyser

- allows detection of extremely small changes



© s::can Messtechnik

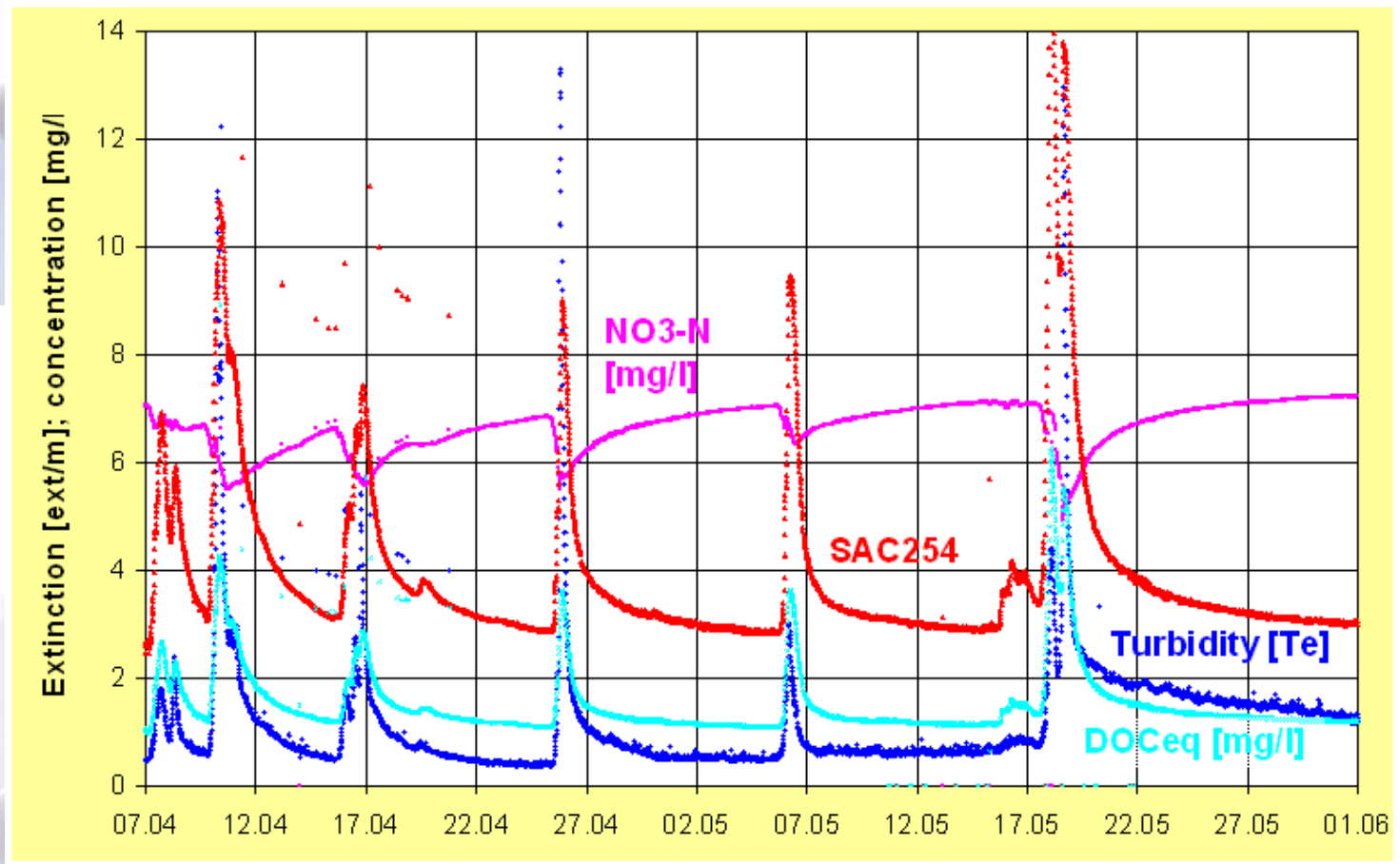
Bank filtrate monitoring



© s::can Messtechnik

Bank filtrate monitoring

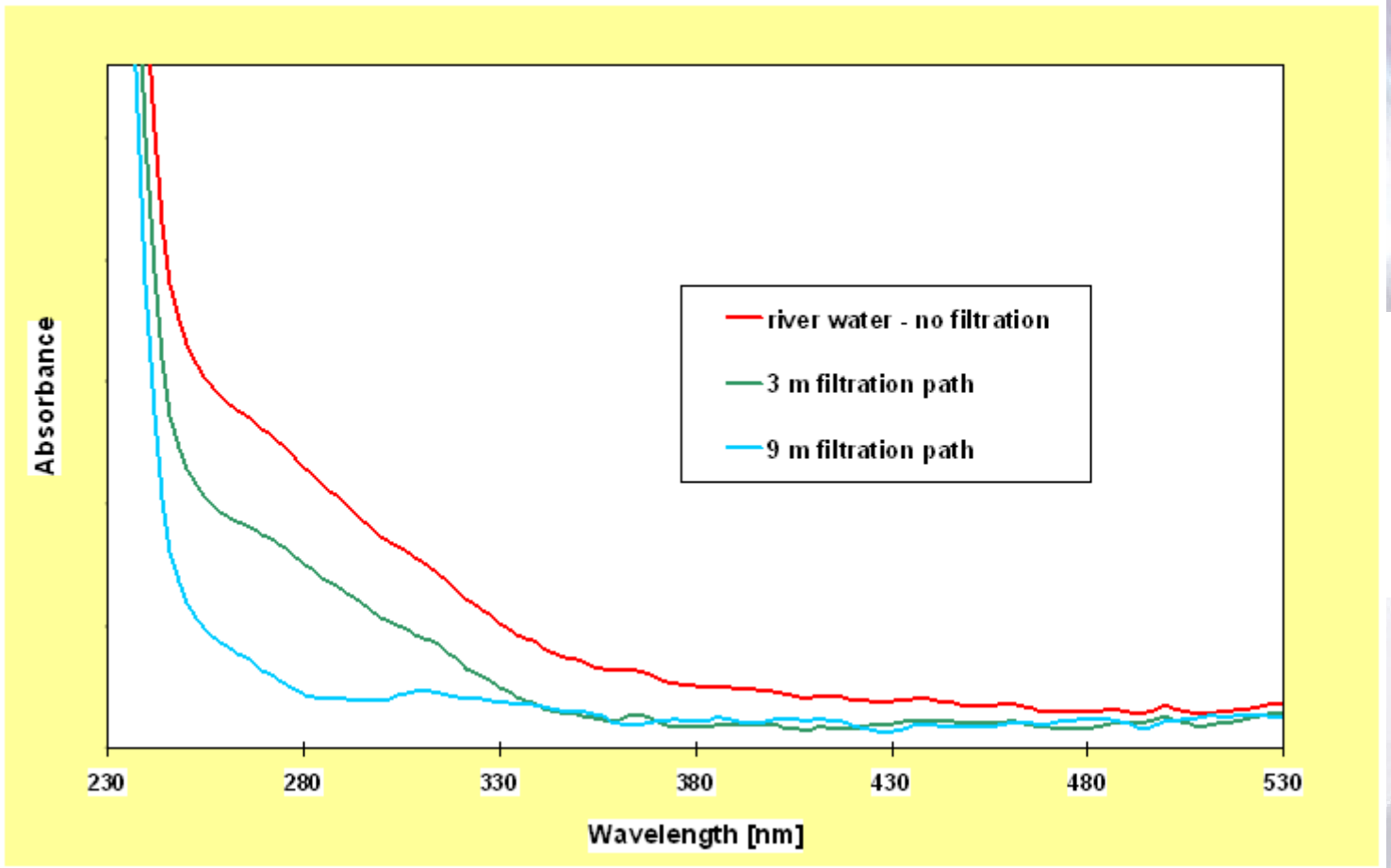
Influence of nearby river on ground water quality



© s::can Messtechnik

Bank filtrate monitoring

Change of spectral properties during bank filtration



© s::can Messtechnik

Summary & Conclusions

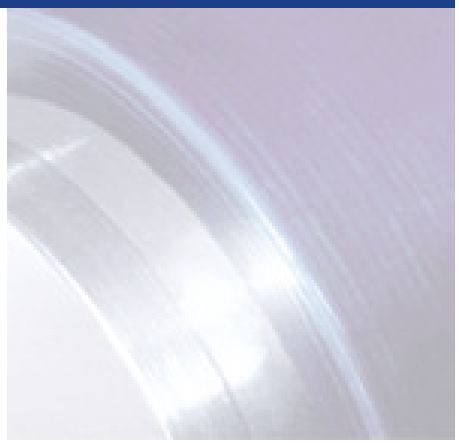
Spectrometry for online & in-situ water quality monitoring

- optical technique offers high precision low maintenance instruments
- allows one instrument to perform many tasks in widely varying applications
- has become a fundamental part of Vienna's Water Quality Management
- successfully applied in sewers for corrosion prevention
- has proven its value for process control of WWTP
- used to monitor and manage natural waters

© s::can Messtechnik

s::can
Intelligent. Optical. Online.

Thank you for your attention!



s::can Messtechnik GmbH

Brigittagasse 22-24

1200 Vienna, Austria

Tel: +43 1 219 73 93

E-mail: office@s-can.at

www.s-can.at

© s::can Messtechnik