Bio-fouling prevention and experiences with the solid-standards in HZG

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Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Outline

- General biofouling prevention in FerryBox system
- Experiences with Scufa-II and secondary solid standard
- PSICAM: Experiences with a flow-through system
  - TSM measurement
  - Chlorophyll-a measurements
  - changing of reflectivity due to biofouling

FerryBox Flow-Through System

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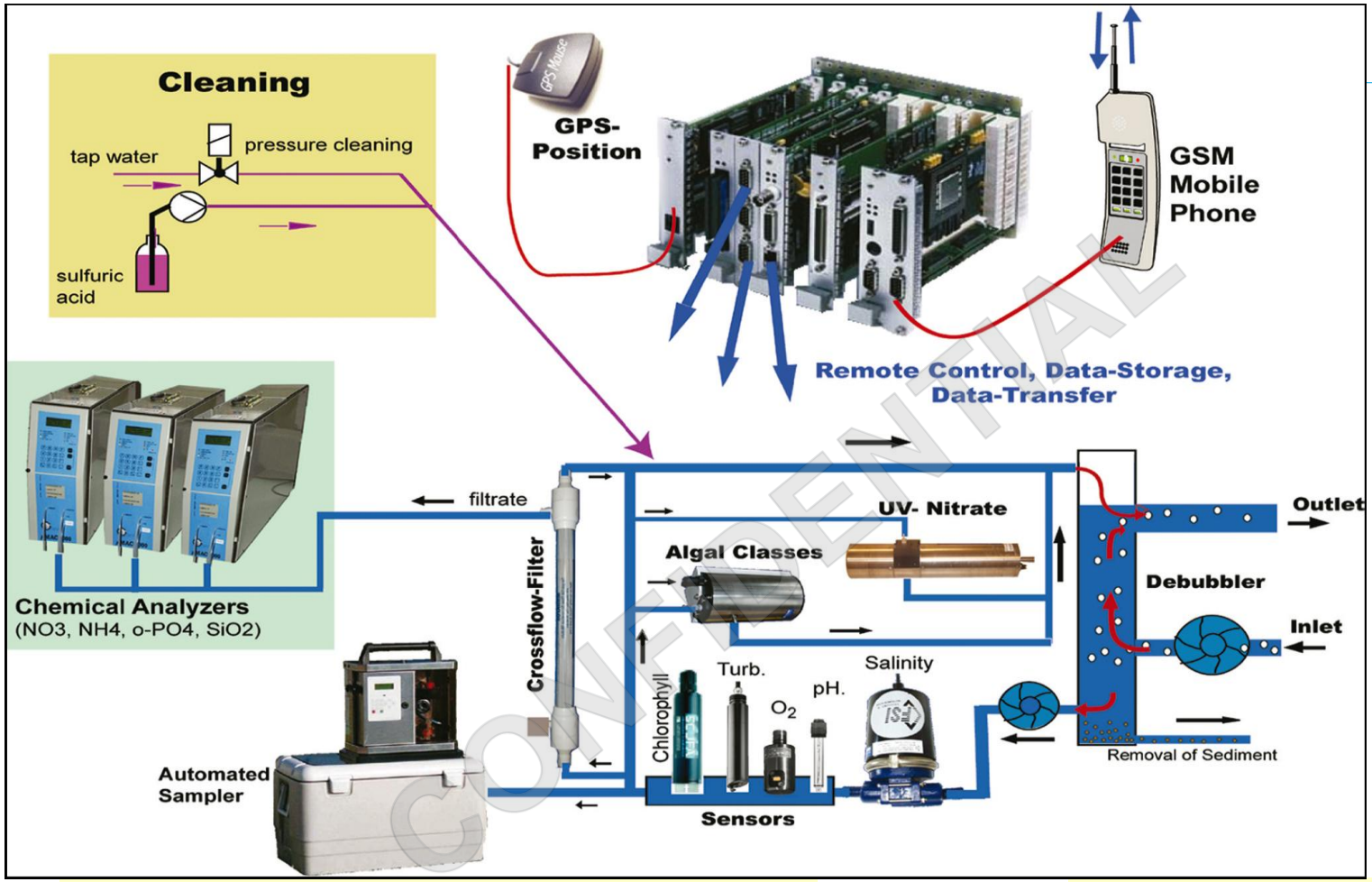

Measured Variables

- temperature
- salinity
- turbidity
- chlorophyll

- oxygen,
- pH
- algal groups
- Nutrients
- pCO2

Main Features:

- running autonomously
- controlled by GPS position
- self cleaning (after each cruise)

+ automatic water sampler for further lab analyis

Biofouling prevention in the HZG FerryBox

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Procedure after each cruise:

- Flushing the whole system with freshwater
  - high pressure rinsing of certain sensors (pH, fluorescence, oxygen)
- Flushing with acidified water (5-10min)
  - Sulfuric acid (pH ~ 2) in order to remove biofilms
  - oxalic acid (removing of iron coatings)

Biofouling without cleaning after one week

Stationary FerryBox Cuxhaven (Elbe estuary)

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Experiences with SCUFA-II secondary solid standard

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FerryBox aboard Lysbris
Check of Scufa-II with secondary solid standard before and after manual cleaning (May 2010 until Feb 2011)

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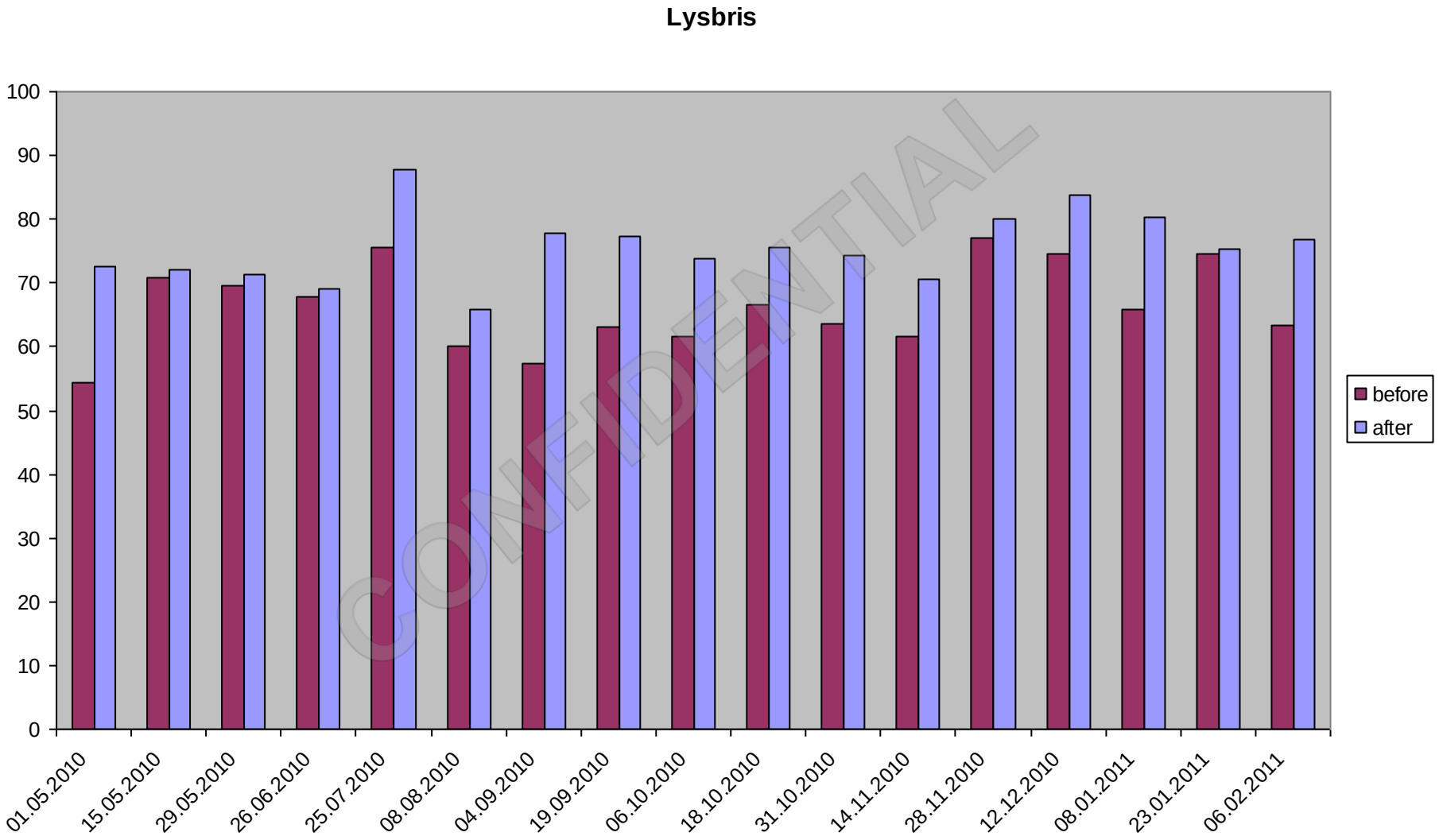
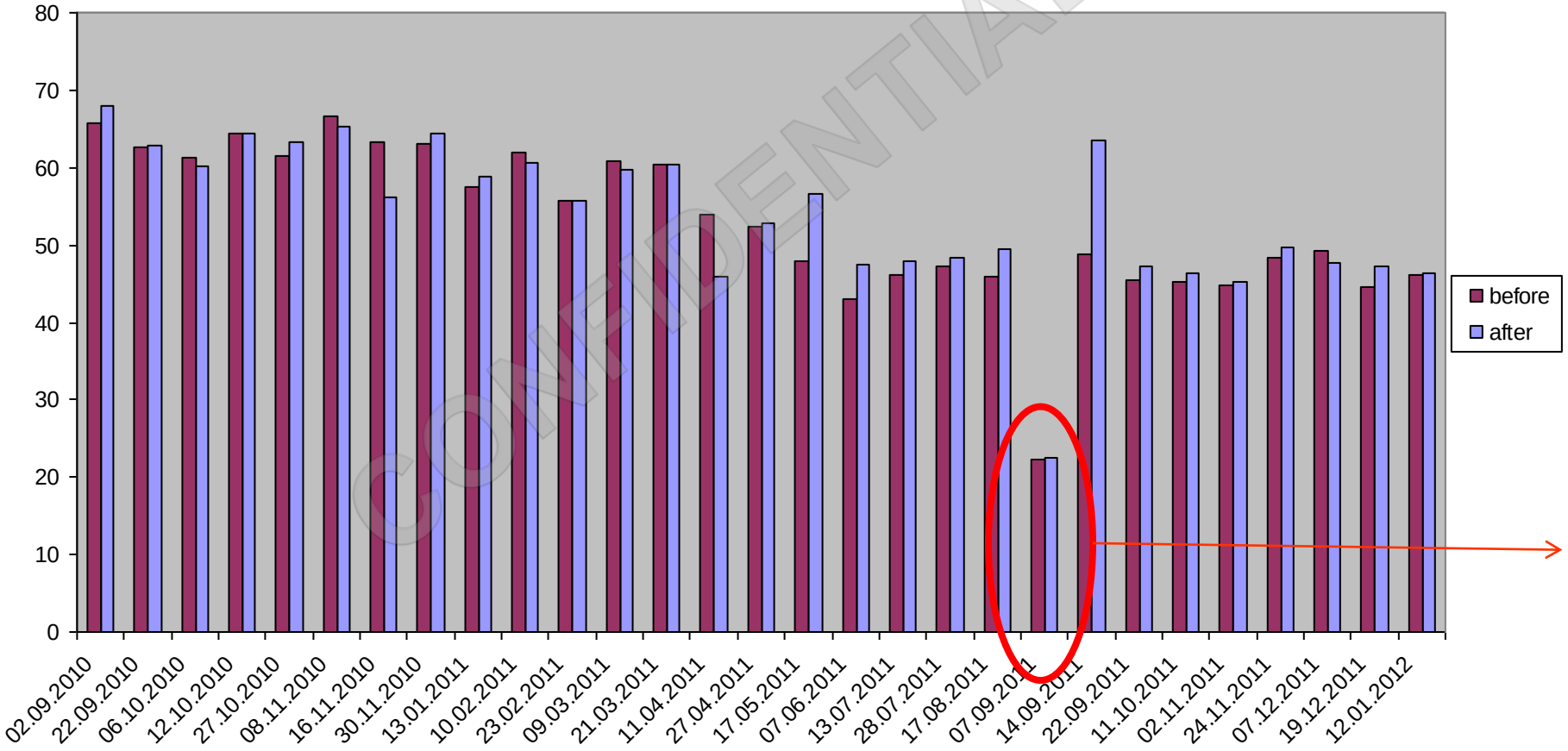


➔ High variability but no significant trend

Fixed Platform Cuxhaven:
Check of Scufa-II with secondary solid standard

Cuxhaven

From Sep 2010 until Jan 2012



Different solid standard used

➔Less variability but significant trend of less fluorescent yield due to high sediment load (sand) destroying the surface of the windows

SCUFA-II Cuxhaven Change of sensitivity due to high sediment load

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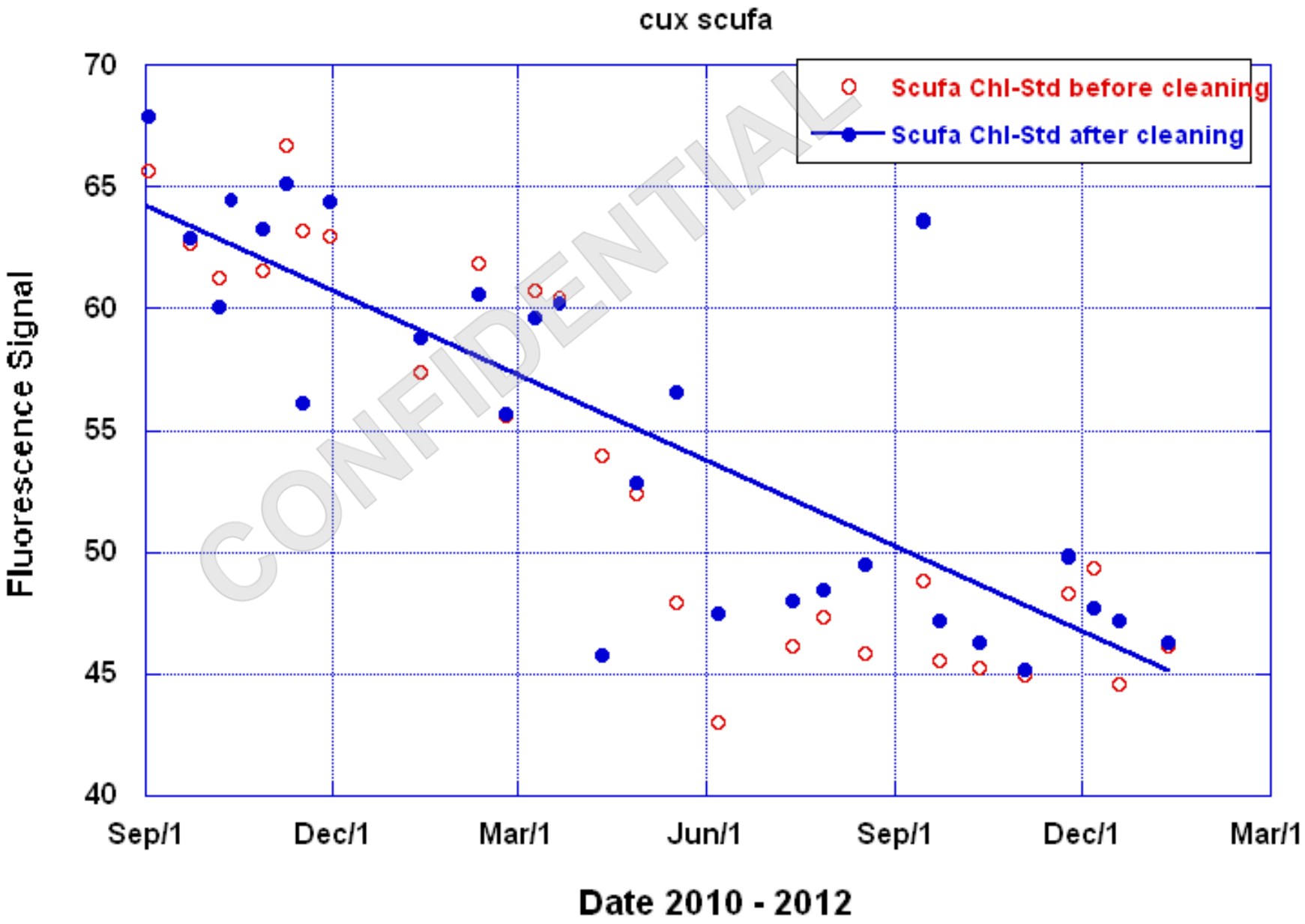

Experiences with the Point-Source Integrating-Cavity Absorption Meter (PSICAM)

Point-Source Integrating-Cavity Absorption Meter (PSICAM)
Working principles (lab version)

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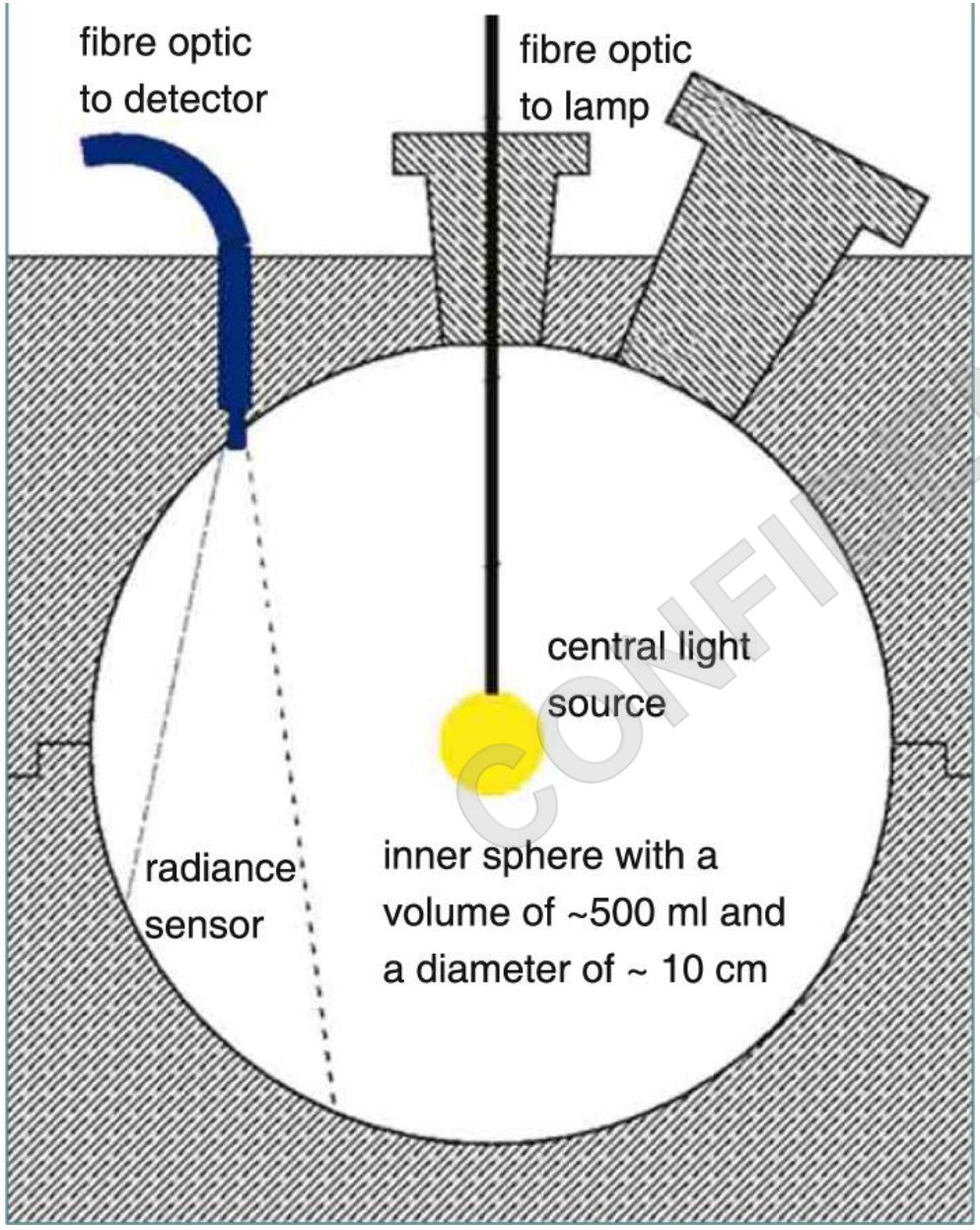
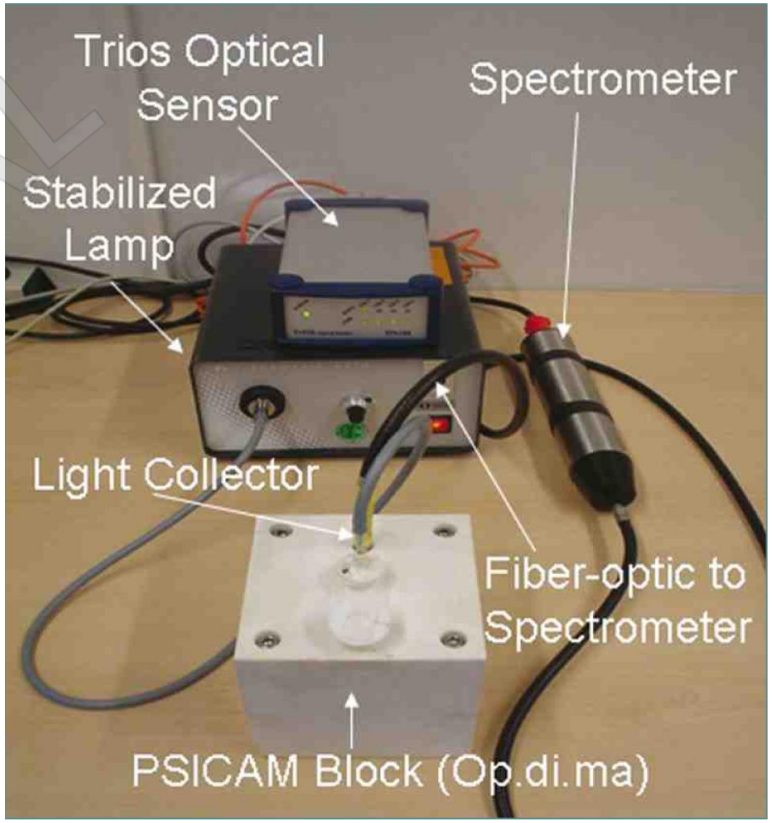


Röttgers et al., 2005



Aim:

Measuring pure absorption without errors caused by particle scattering

Inner diameter: 9.5 cm

Differentiation of algal groups from absorption spectra

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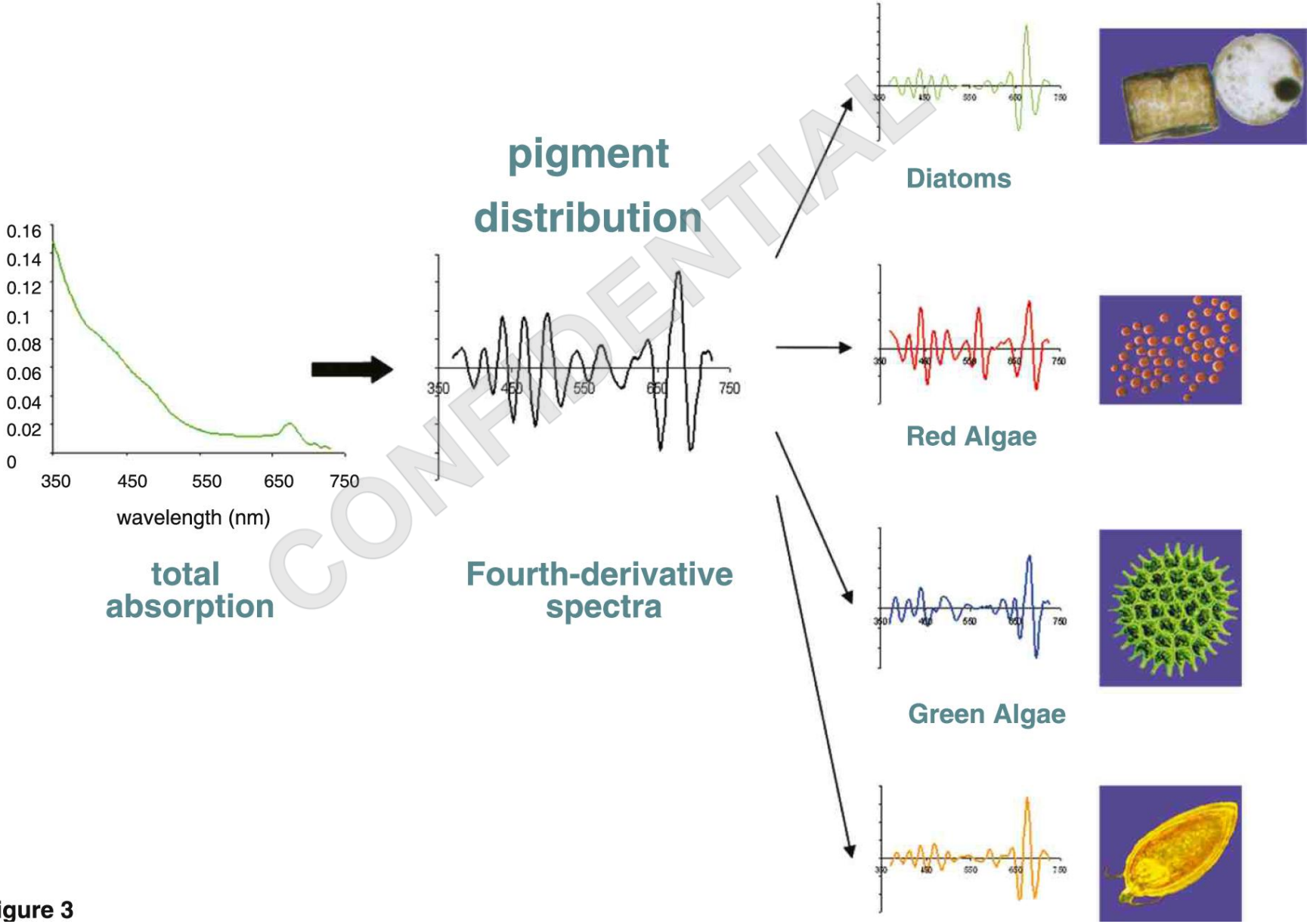

Figure 3

Point-Source Integrating-Cavity Absorption Meter (PSICAM)
Working principles (flow-through version)

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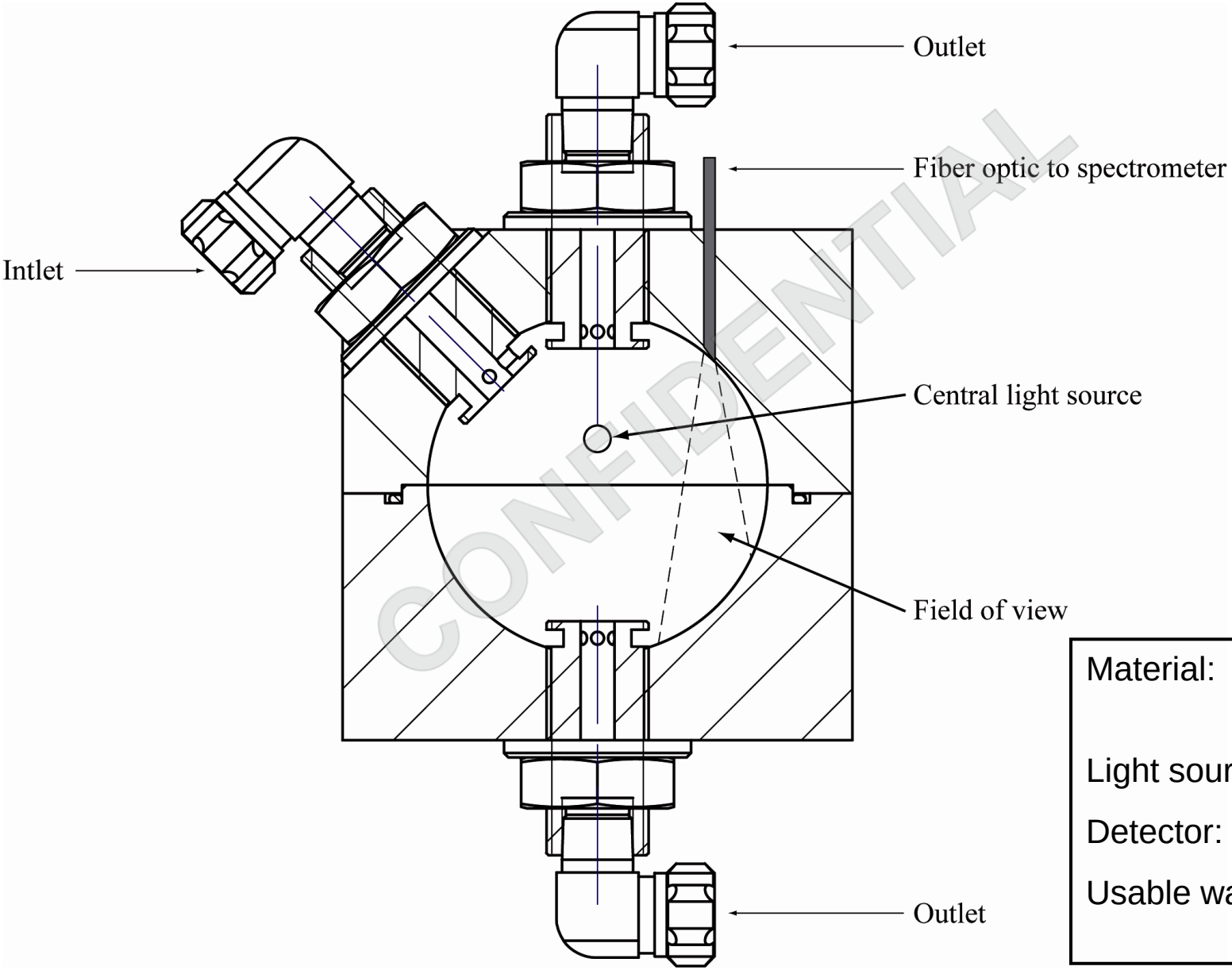


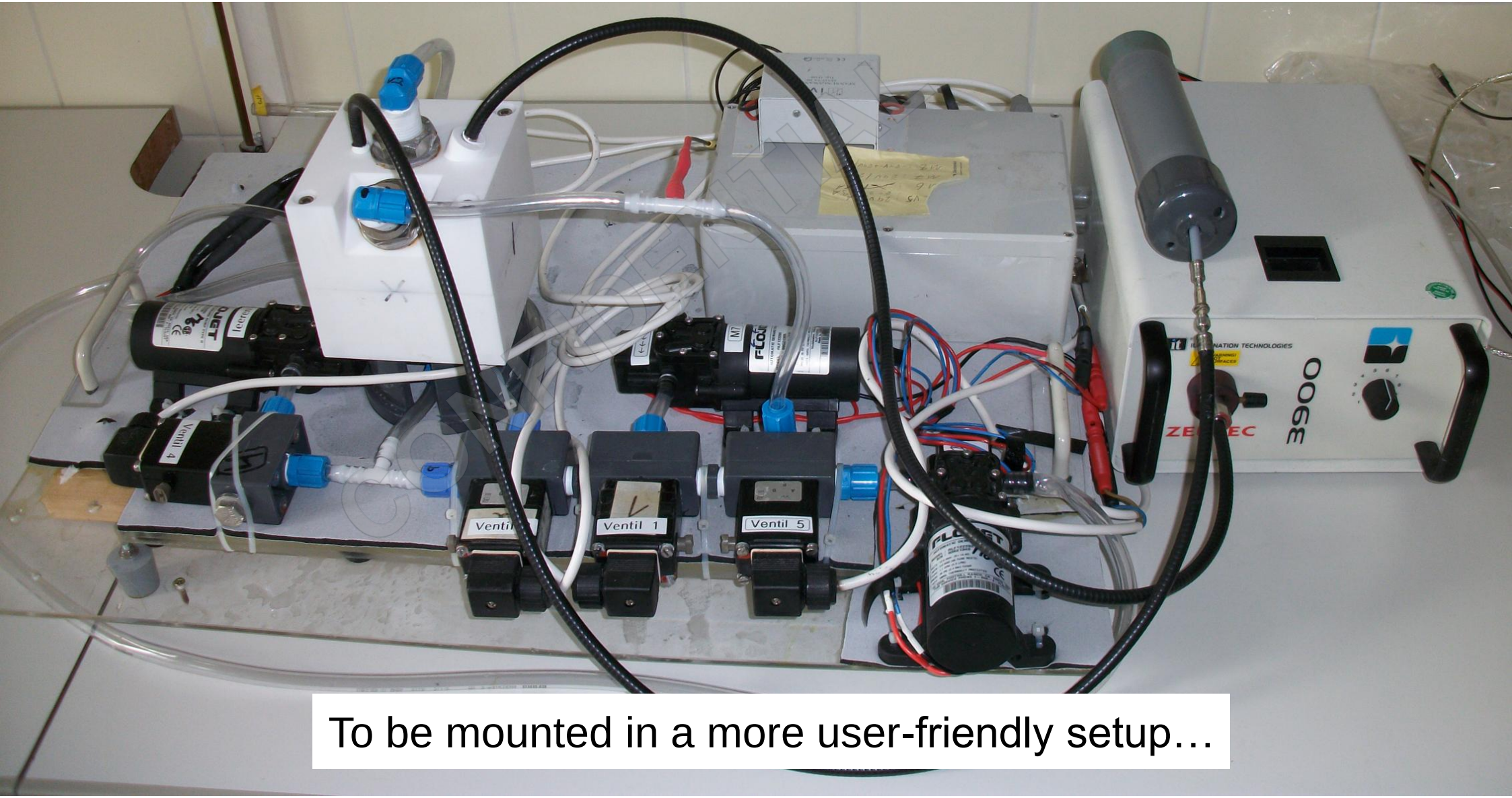
Material: OP.DI.MA (lab vers.)
Teflon (flow-through vers.)

Light source: 150W halogen bulb

Detector: Ramses UV-vis (TriOs)

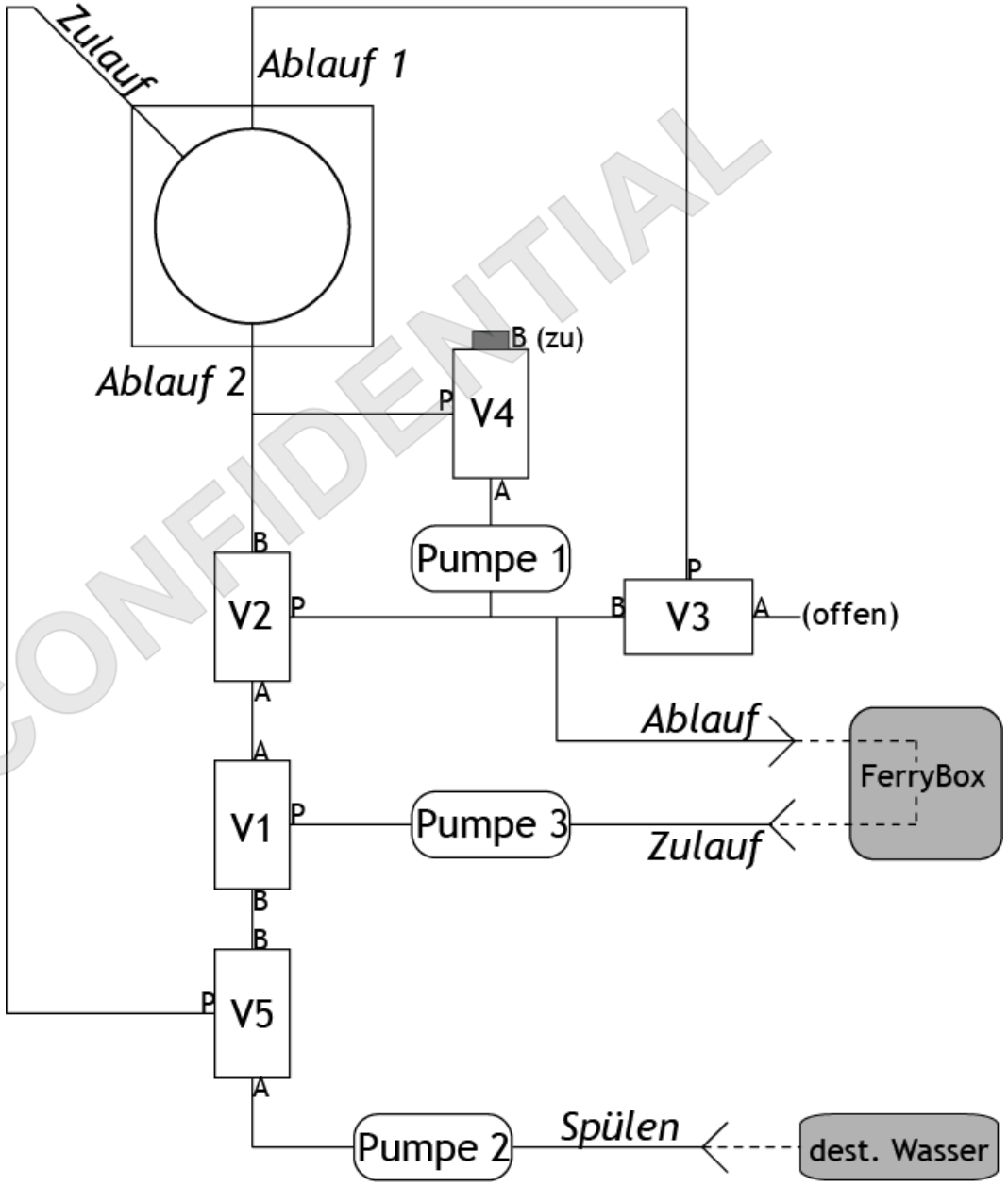
Usable wavelengths: ~400 – 720 nm
(2 nm steps)

Test Version of FlowThrough PSICAM



To be mounted in a more user-friendly setup…

Working principles

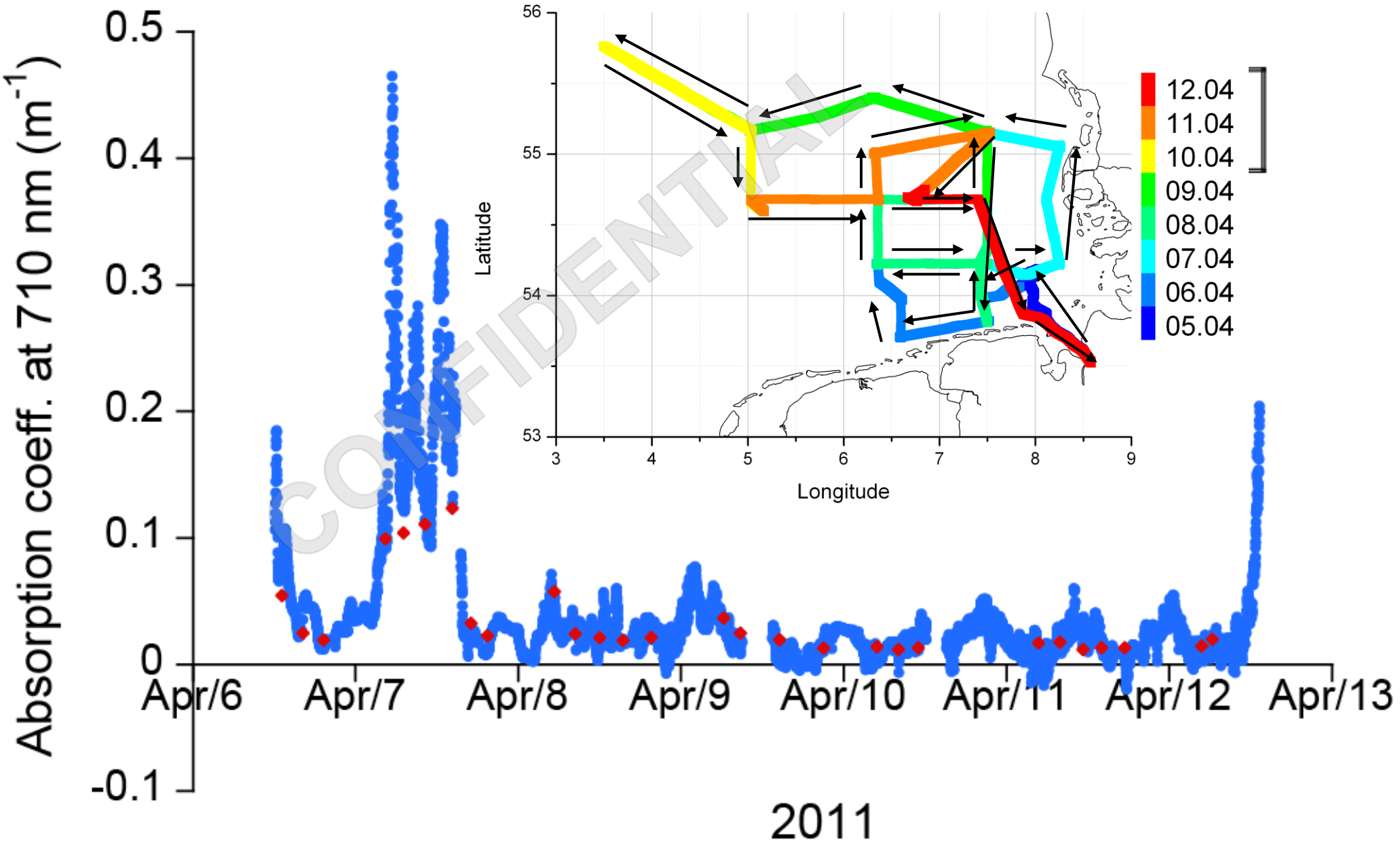


Working principles

Workflow for continuous measurements

Reflectivity determination / calibration (1 / day)	Measurement of purified water and Nigrosin dye solution with a known absorption coefficient.
Sampling (continuously)	Sample measurement in a (down to) 5 sec interval with an integration time of 1024 ms.
Cleaning (at each station)	Flushing sequentially with Ethanol/Extran® and 0.5% Na-hypochlorite (≙0.06% active Cl for bleaching). Manually cleaning with ethanol at start of the cruise.
Reference sampling (before and after each cleaning)	Between sample measurements purified water is measured to determine changes in light regime and to get a blank value for absorption calculation.

Samples of in situ measurements (“TSM“)



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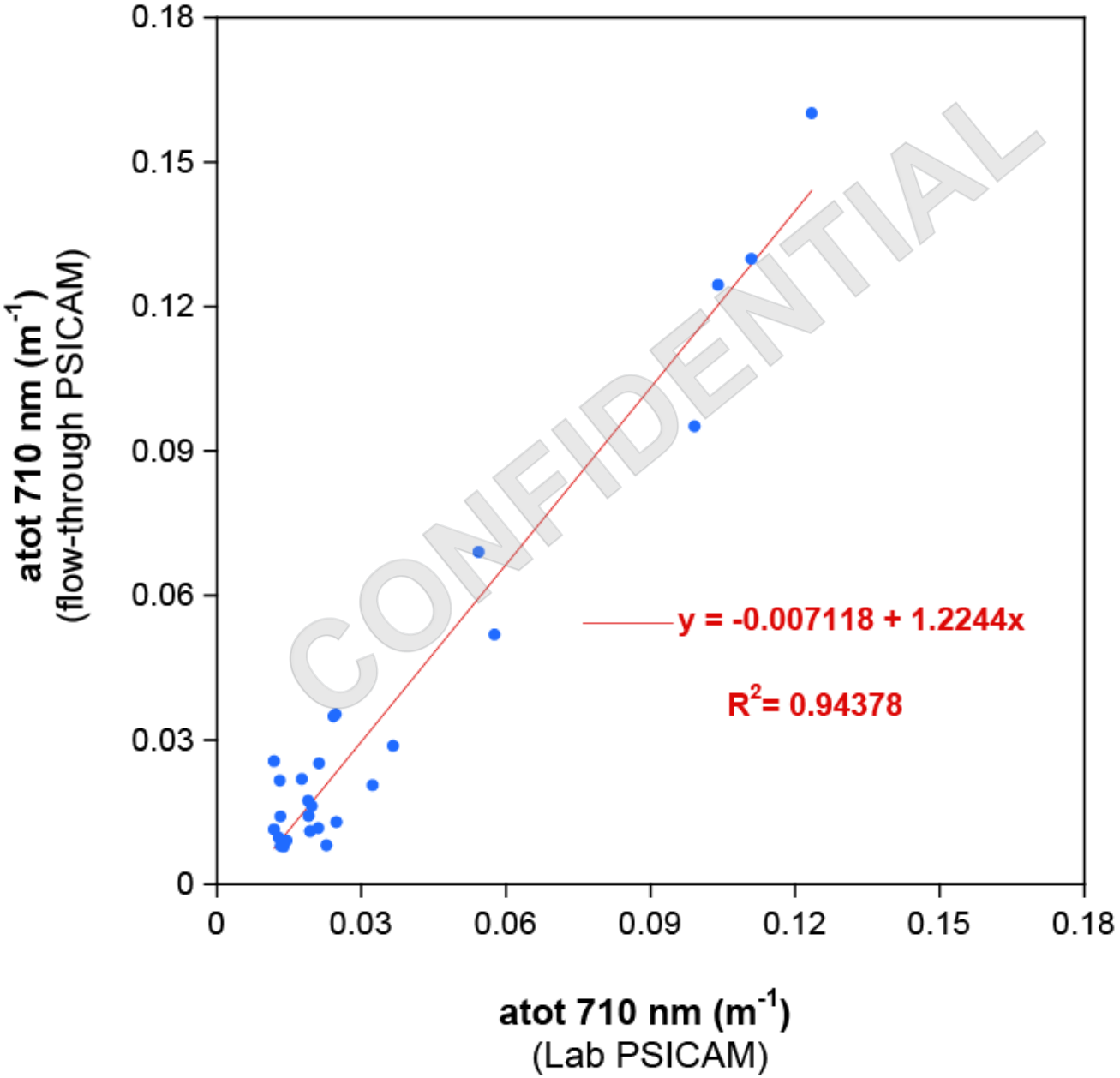
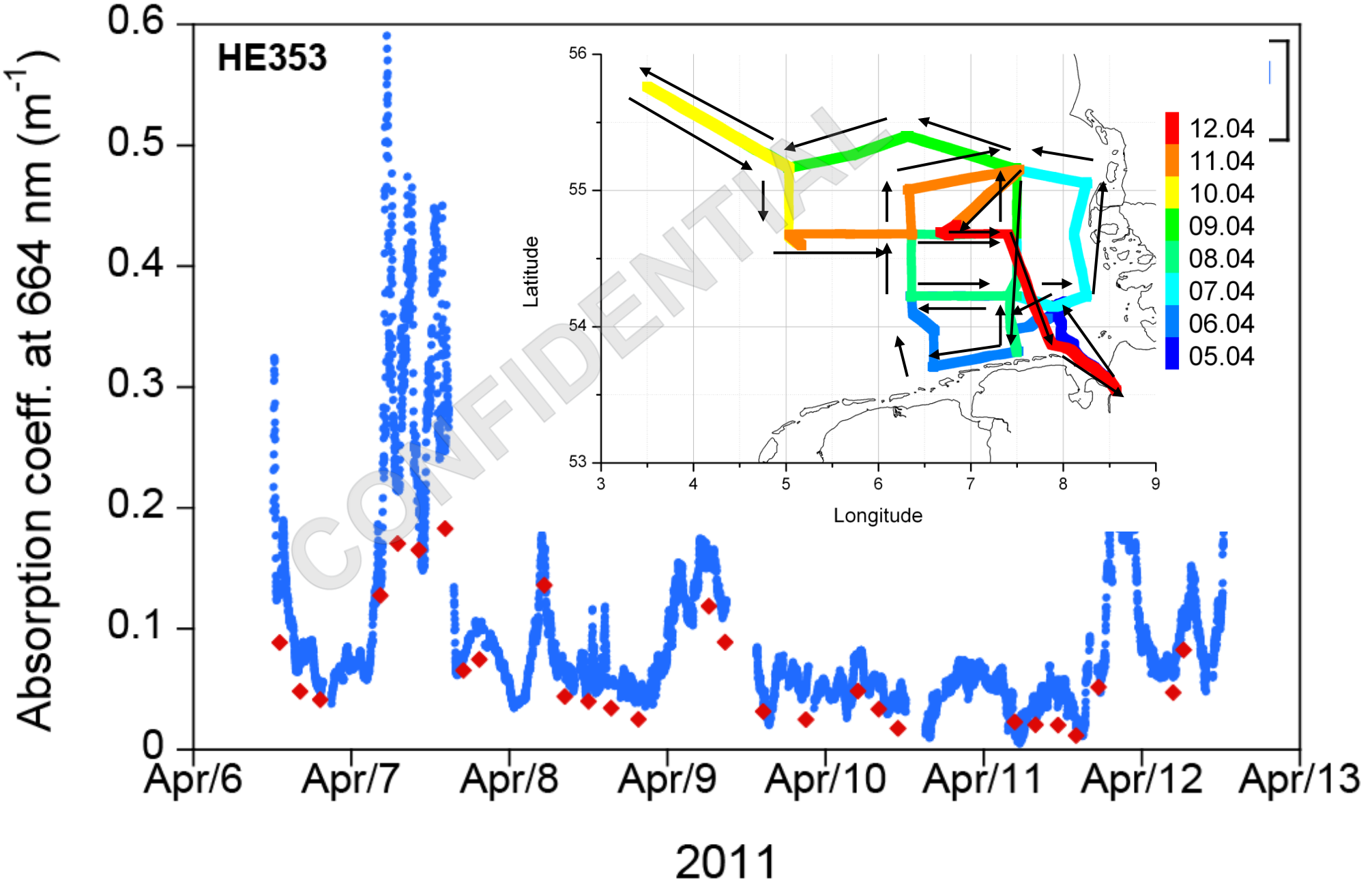


Correlation of PSICAMs at 710 nm during Heincke cruise HE353, April 2011

Samples of in situ measurements (“Chl-a“)



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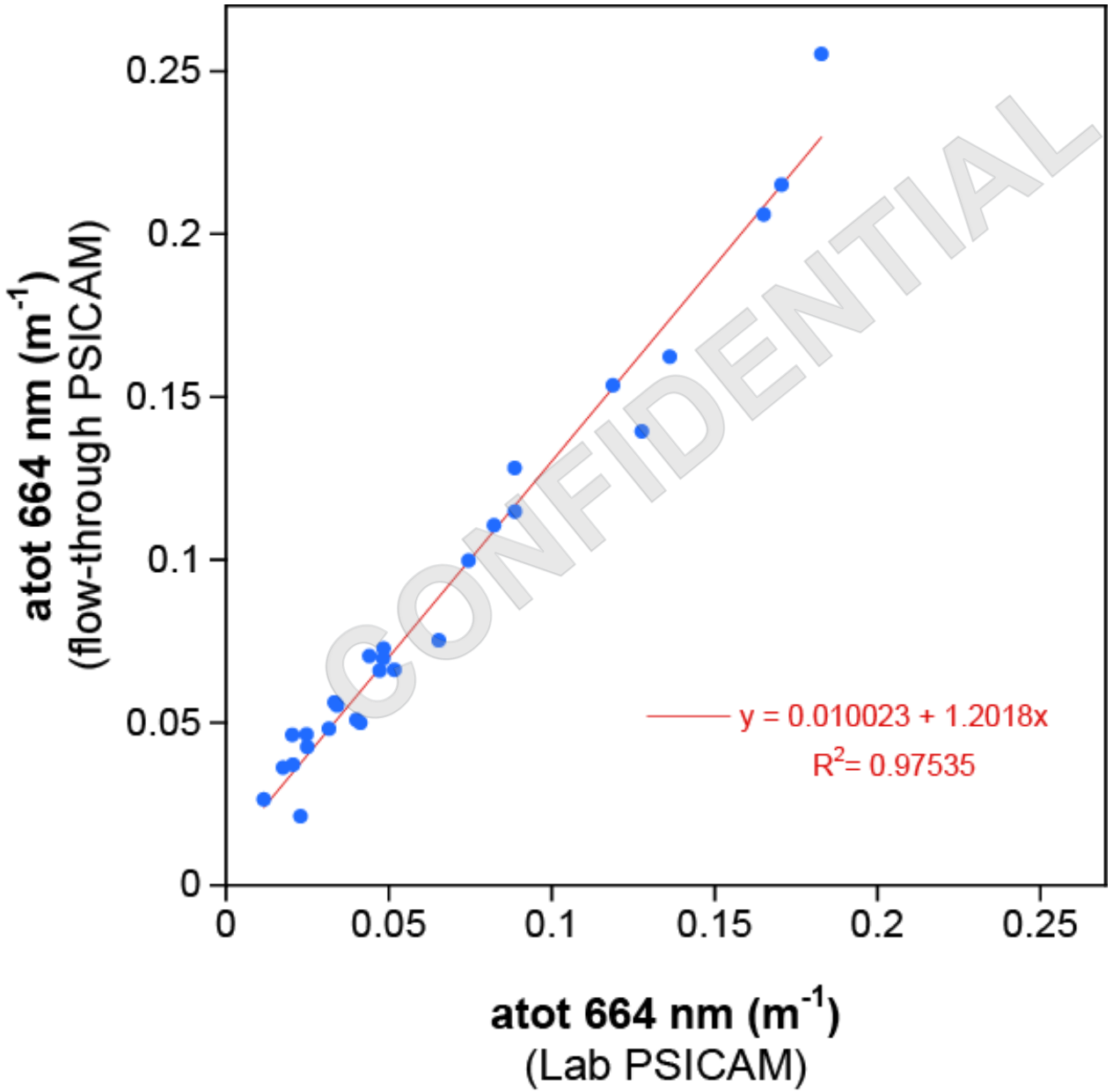
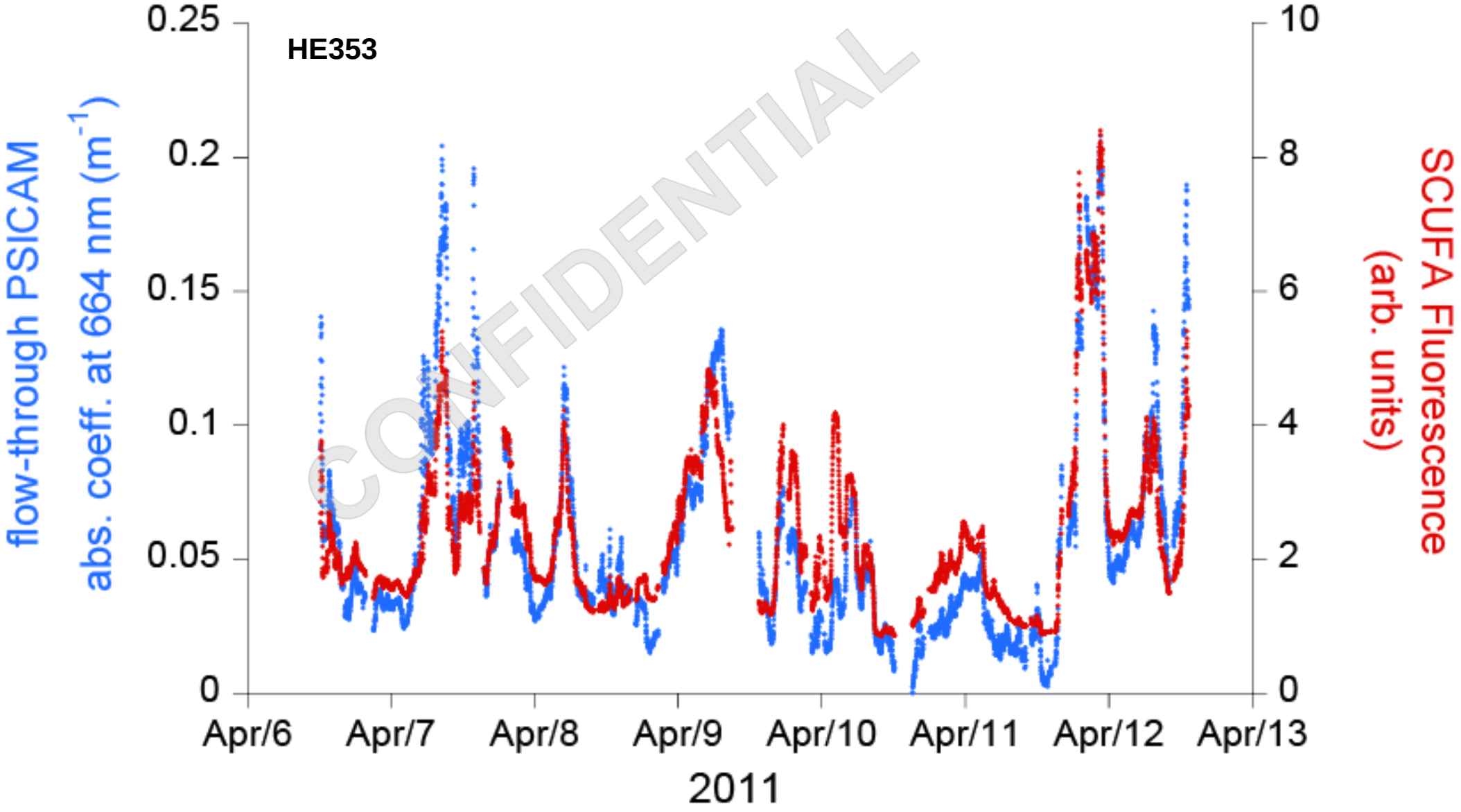
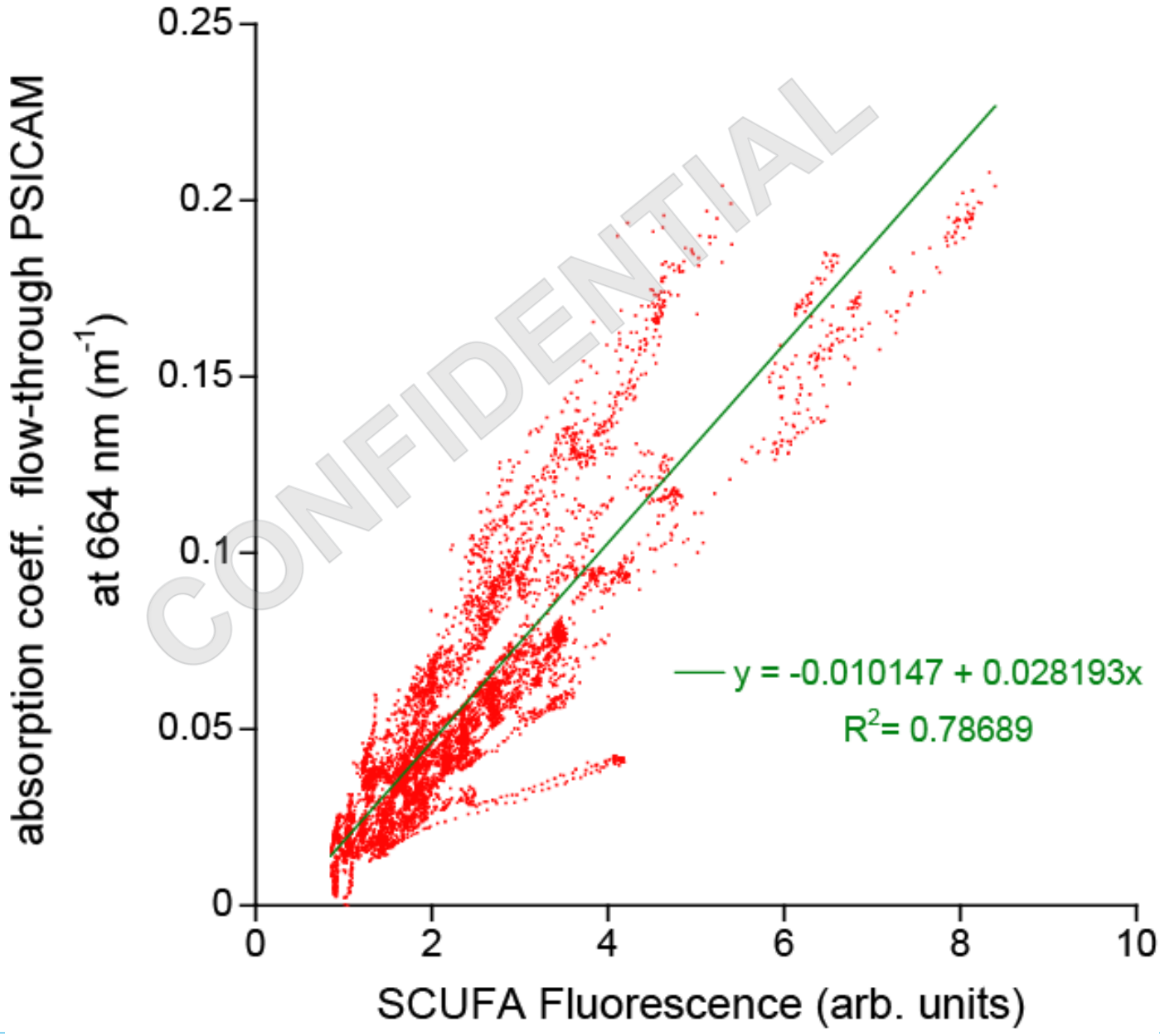


Correlation of PSICAMs at 664 nm during Heincke cruise HE353, April 2011

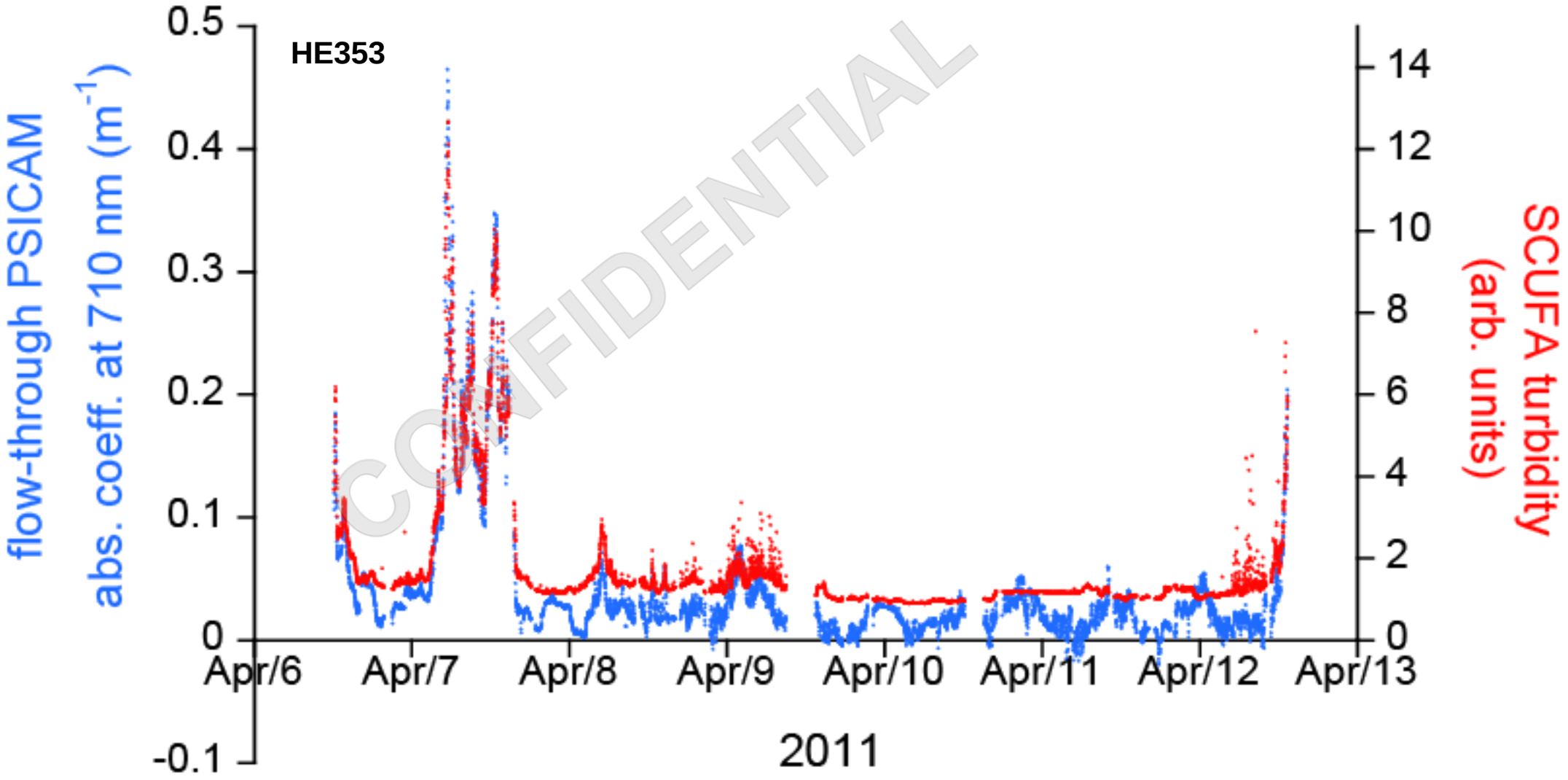
Comparison to fluorescence measurements



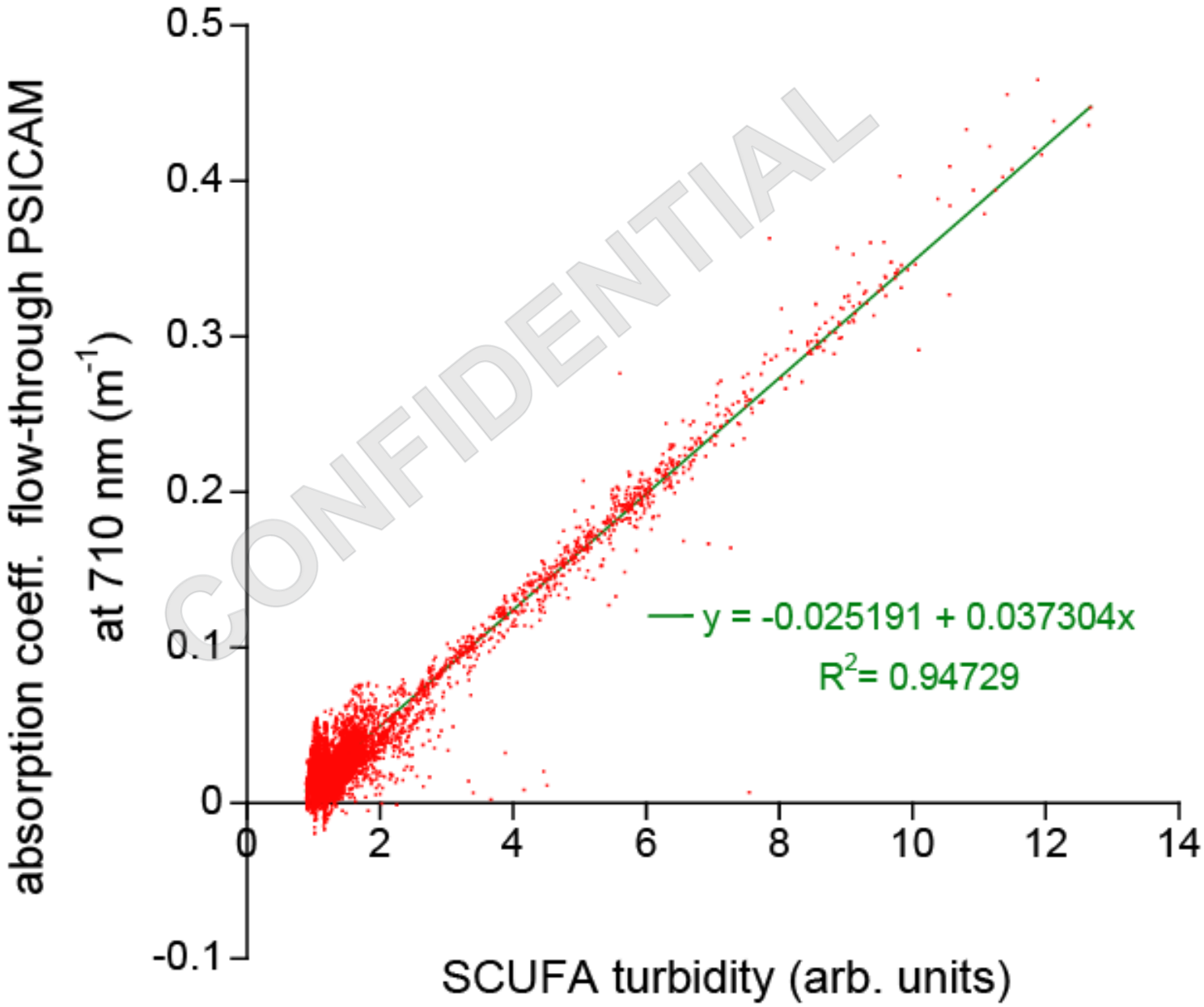
Comparison to fluorescence measurements



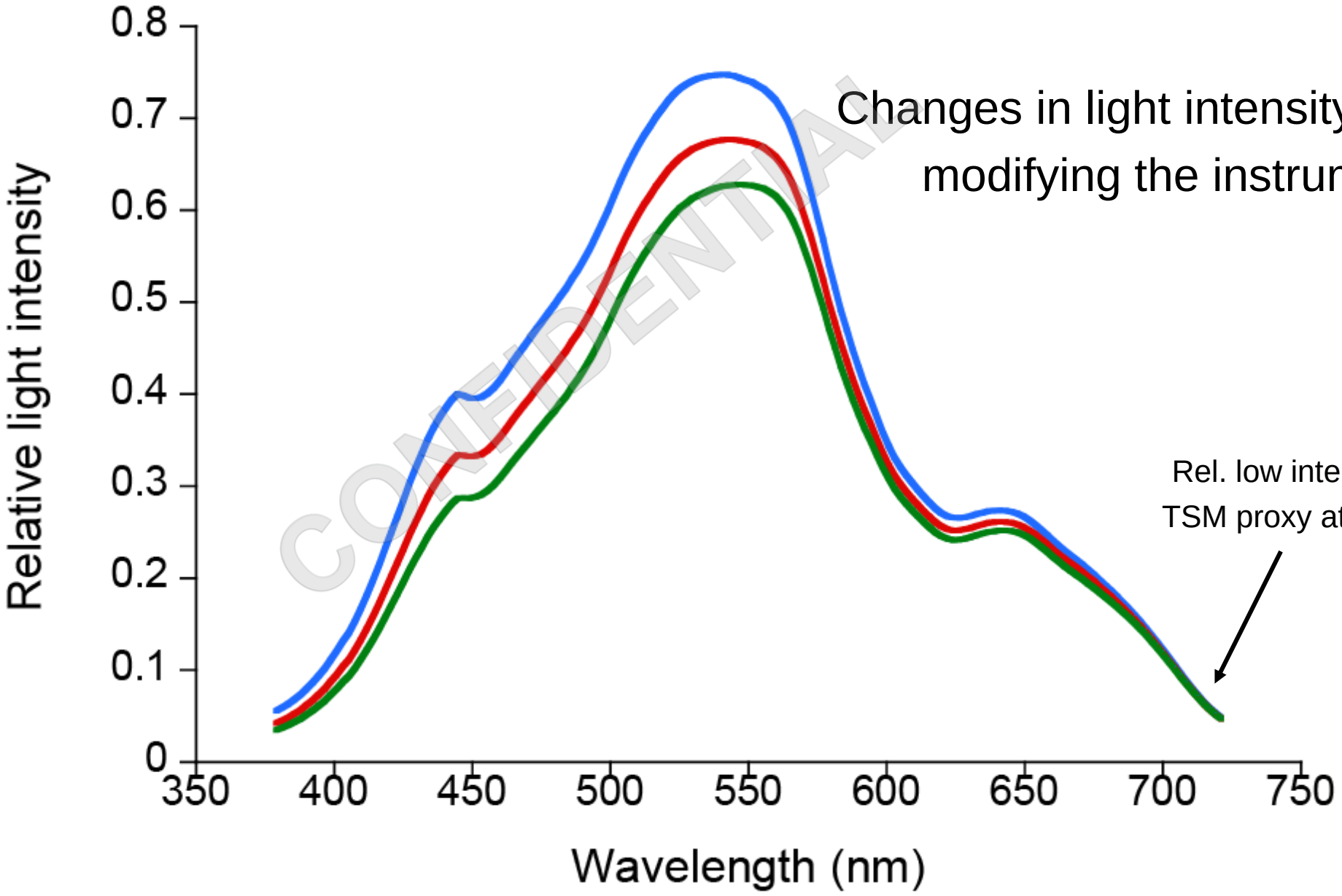
Comparison to turbidity measurements

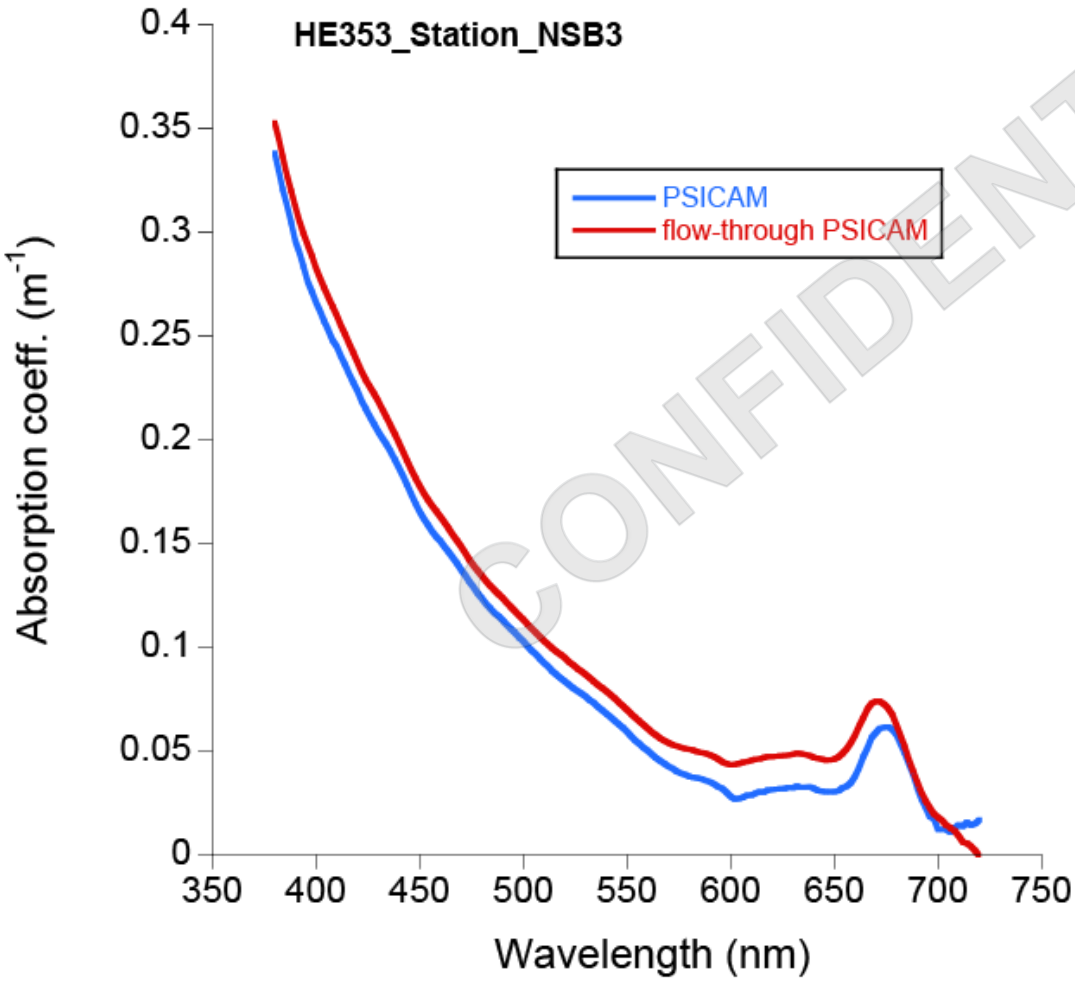


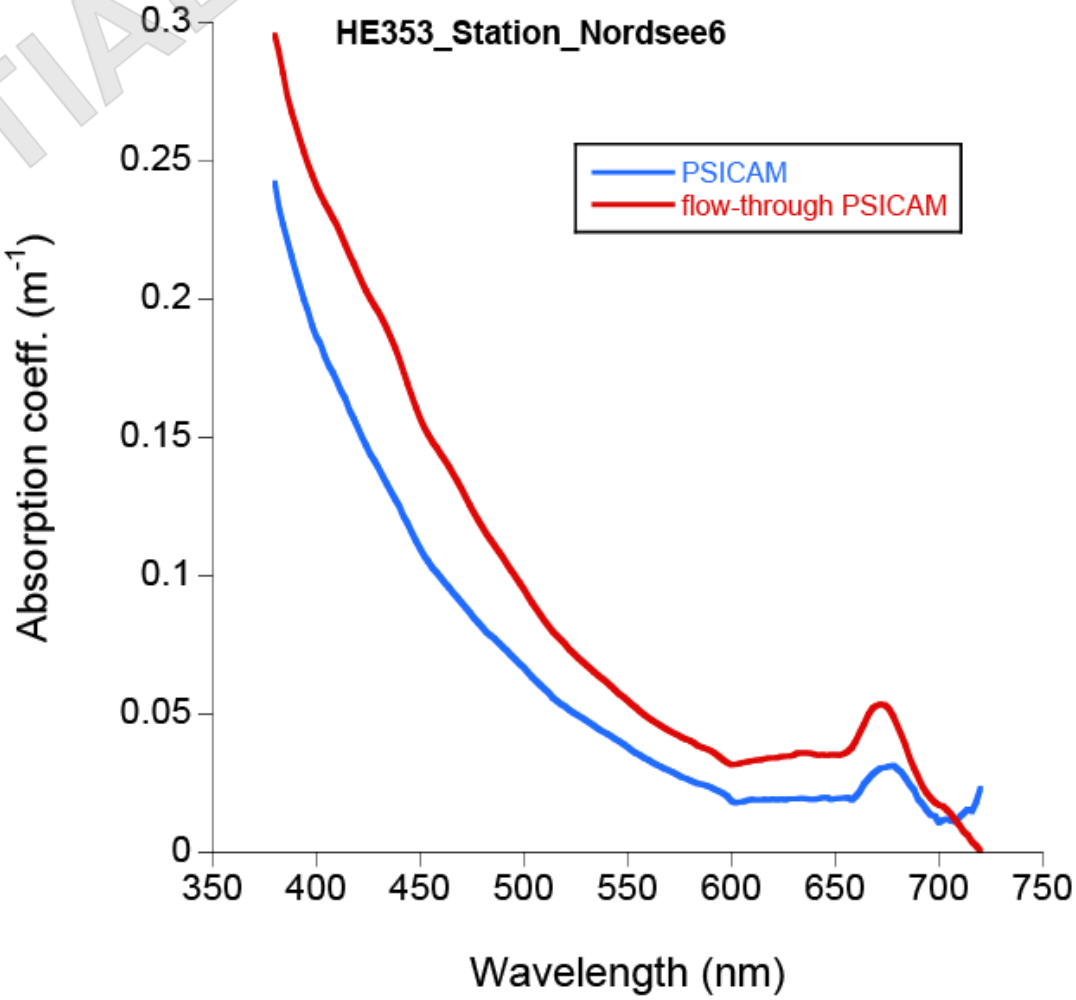
Comparison to turbidity measurements



General problems





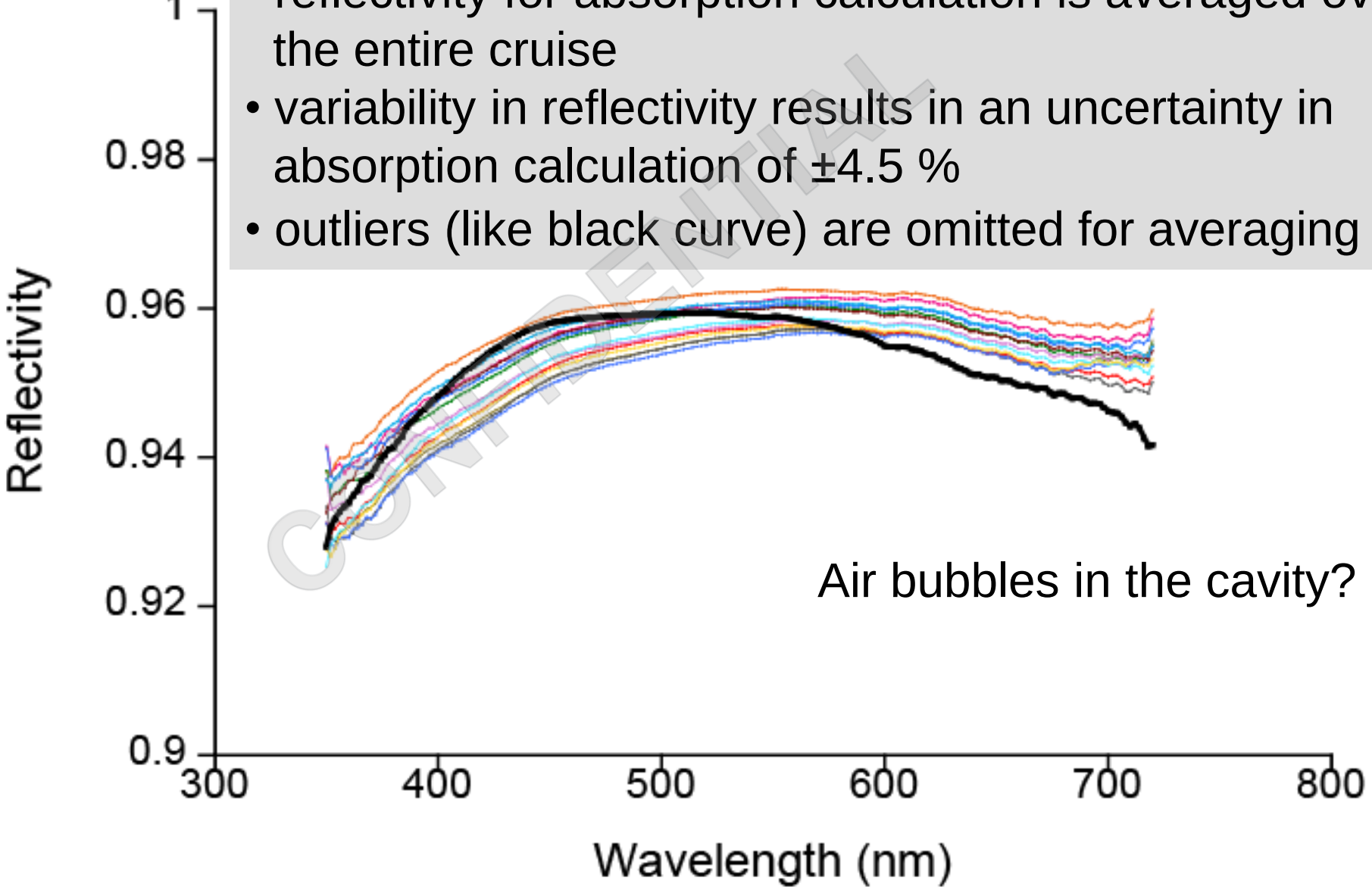


General problems

The reflectivity of the PSICAM is strongly affected by biofilms or other contamination. But even after intense cleaning cycles including bleaching the reflectivity scatters during a cruise.

General problems

- reflectivity for absorption calculation is averaged over the entire cruise
- variability in reflectivity results in an uncertainty in absorption calculation of ±4.5 %
- outliers (like black curve) are omitted for averaging



Air bubbles in the cavity?

General problems and possible solutions

- For calibration, a low concentrated Nigrosin dye solution with a known absorption coefficient is needed, but it is not stable
  - ➢ Automated on site preparation of calibration dye? But how to determine its absorption coeff.?
  - ➢ Solid matter calibration dye (e.g. ball) with a known absorption?
    - ➢ But how to bring it in and out the cavity?
      (moving parts may be problematic, shutter needed…)

- Just very fresh purified water (MilliQ, 18.2 MΩ) must be used for calibration solutions and reflectance determination
  - ➢ Installation of automated water purification module besides the PSICAM?

Conclusions

- The flow-through PSICAM delivers absorption data in a high frequency from 400 to 720 nm
- Comparison to lab PSICAM and fluorescence measurements shows a good correlation
- The setup will be mounted in a user-friendly frame
- We have to overcome some problems:
  - light source: change to LED
  - automatic cleaning, calibration, and reference measurements
  - calibration standard: solid matter?
  - provide purified water for reference measurements

Outlook

- Installation for a long-time test in Cuxhaven FerryBox Container
- Integration in international project “ProTool” (www.protool-project.eu)
- An in situ prototype is constructed with TriOS

- In combination with specific absorption spectra of algae, an identification of classes may be possible by fingerprints “quasi-online”

  (Dissertation of Steffen Gehnke, and further work to do)

Thanks for your attention!