STATuS – sensor for humic substance and protein determination in drinking water.

Anna Dahlhaus

bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de




Drinking water

81,635,845 of 82,260,690 (99.24%) of German citizens has access to the public water supply (data from 2007). Everybody expects fresh and safe water from the tap.

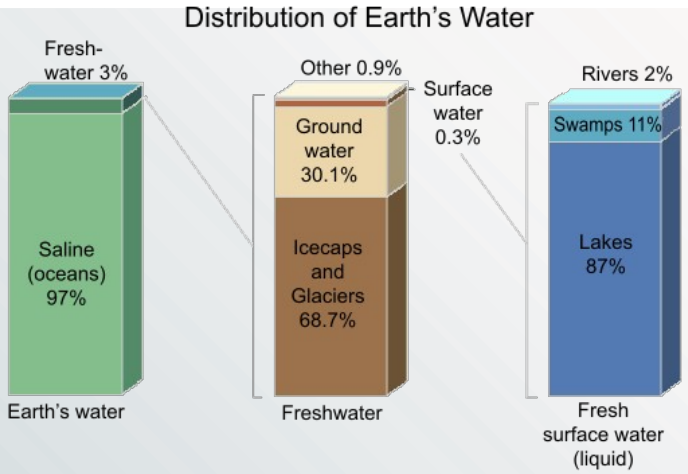
•

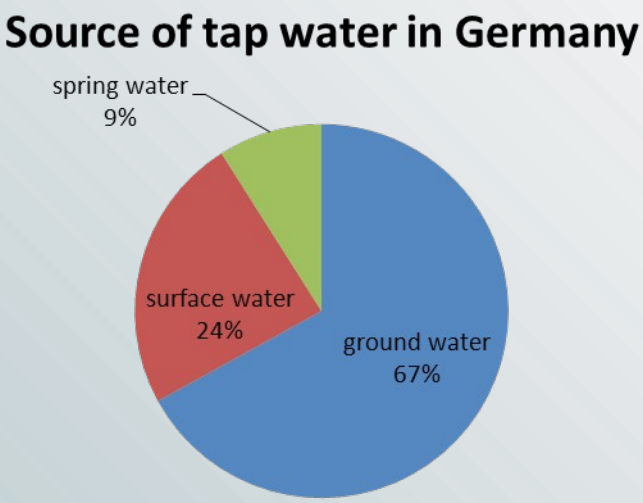
To ensure the safety of tap water before it reaches the consumer, water goes through a water treatment plant. To guaranty a high water quality it is important to avoid high organic substance concentrations.

The monitoring of water for organic substances could not only improve the quality of tap water, but it can help to optimse the processing of water treatment as well.

•

Water Technology Center Dresden (TZW) with bbe Moldaenke wishes to create an online instrument for the fast fluorometric determination of organic contents of drinking water.








DOC in drinking water

Humic substances

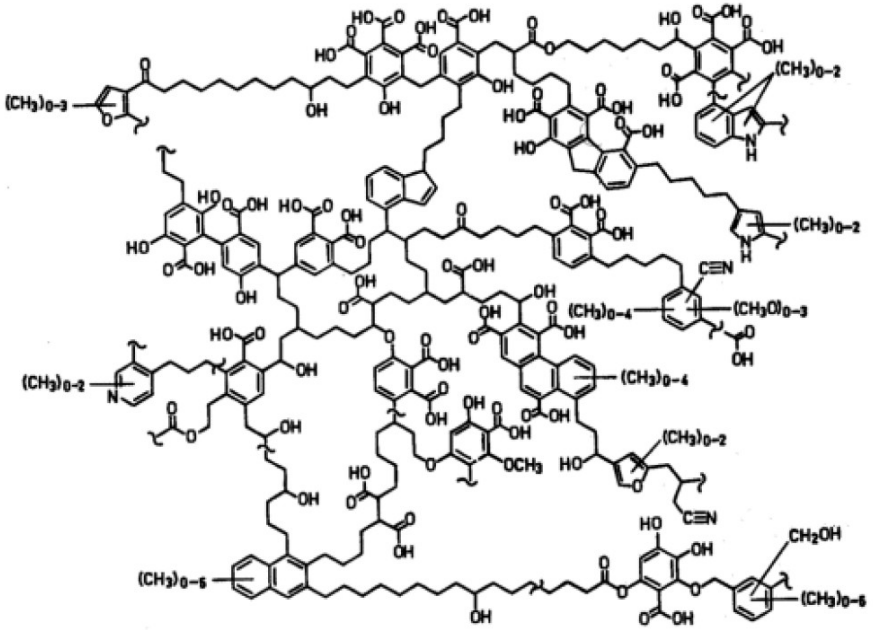
- humic acid
- fulvic acid

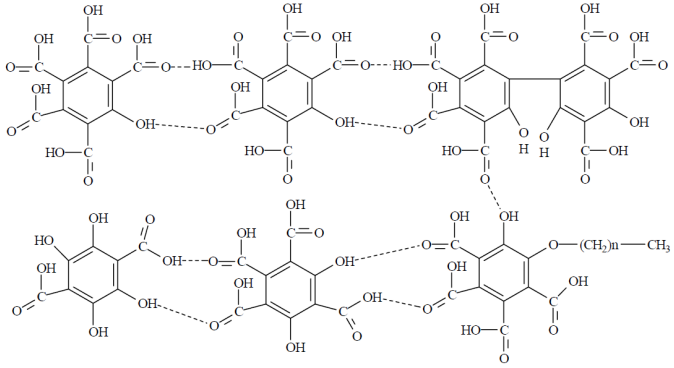
Biopolimers

- bound/free amino acids

bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de





Humic substances

Model of humic acid
(Schulten & Schnitzer 1997)

Model of fulvic acid
(Morill 1982)

bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de




Our goals

- Detection of substances basing on their fluorescence and absorption spectrum:
  - humic substances (0-10mg/l, 0,1mg/L resolution)
  - tryptophan and tyrosin (0-50µg/l, 1µg/L resolution) and proteins
  - chlorophyll and other algae pigments

- Online instrument for water monitoring.

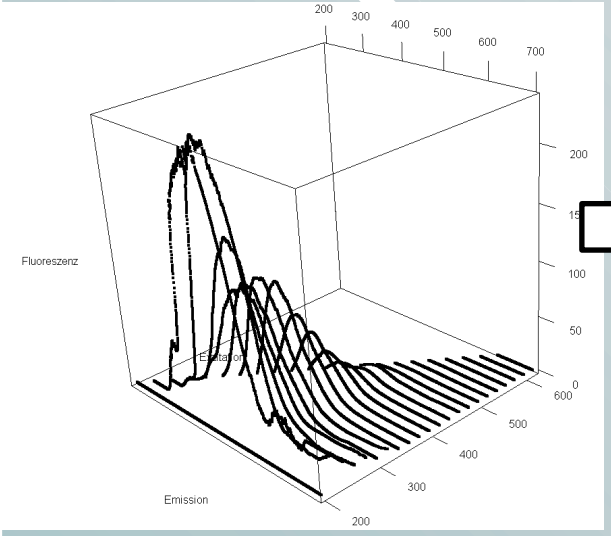
bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de

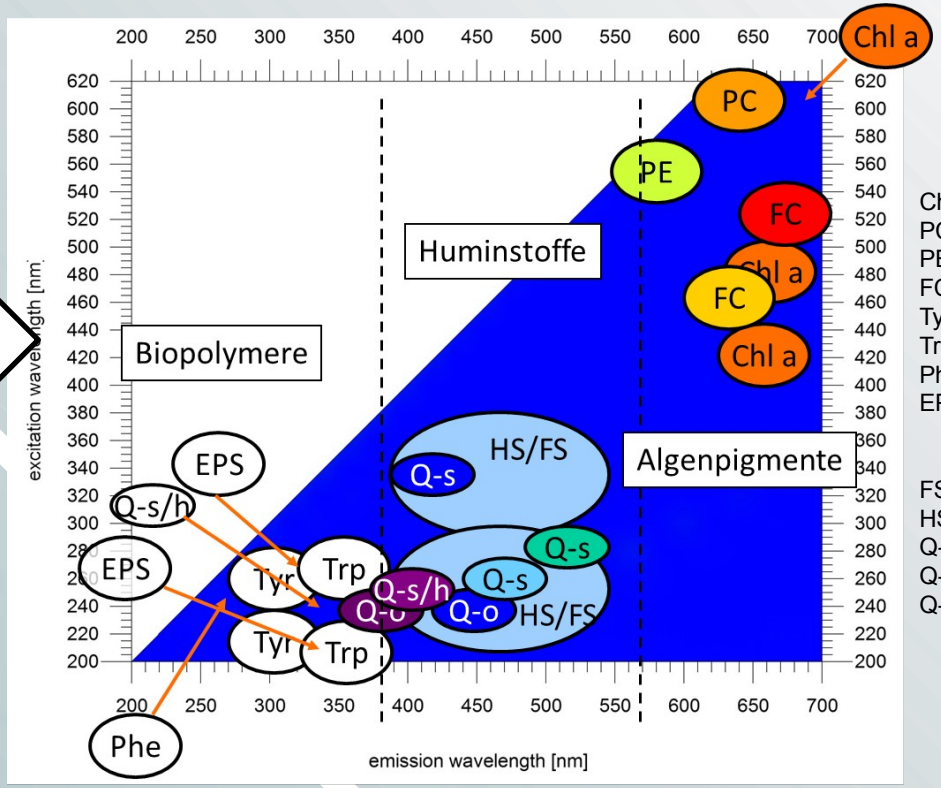



Fluorescence of organic water content

Emission spectrum under variation of excitation – EEM (Excitation-Emission-Matrix)

[Martin Wagner, TZW Dresden]





Chl A	Chlorophyll A
PC	Phycocyanin
PE	Phycoerythrin
FC	Fucoxanthin
Tyr	Tyrosin
Trp	Tryptophan
Phe	Phenylalanin
EPS	extracellular polymeric substances
FS	fulvic acid like
HS	humic acid like
Q-o	Quinone (oxidized)
Q-s	Semiquinone
Q-h	Hydroquinone

bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de




Chosen constructions of a fluorometer

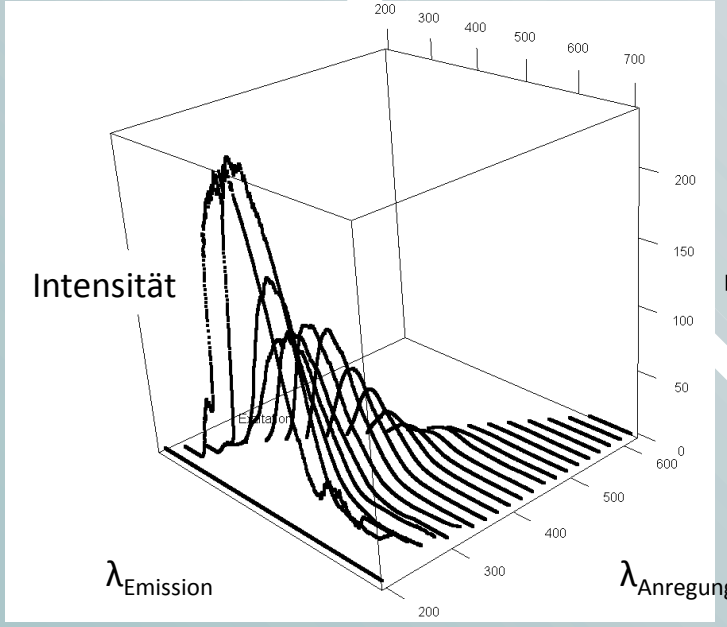
- LEDs + Photodetectors
-

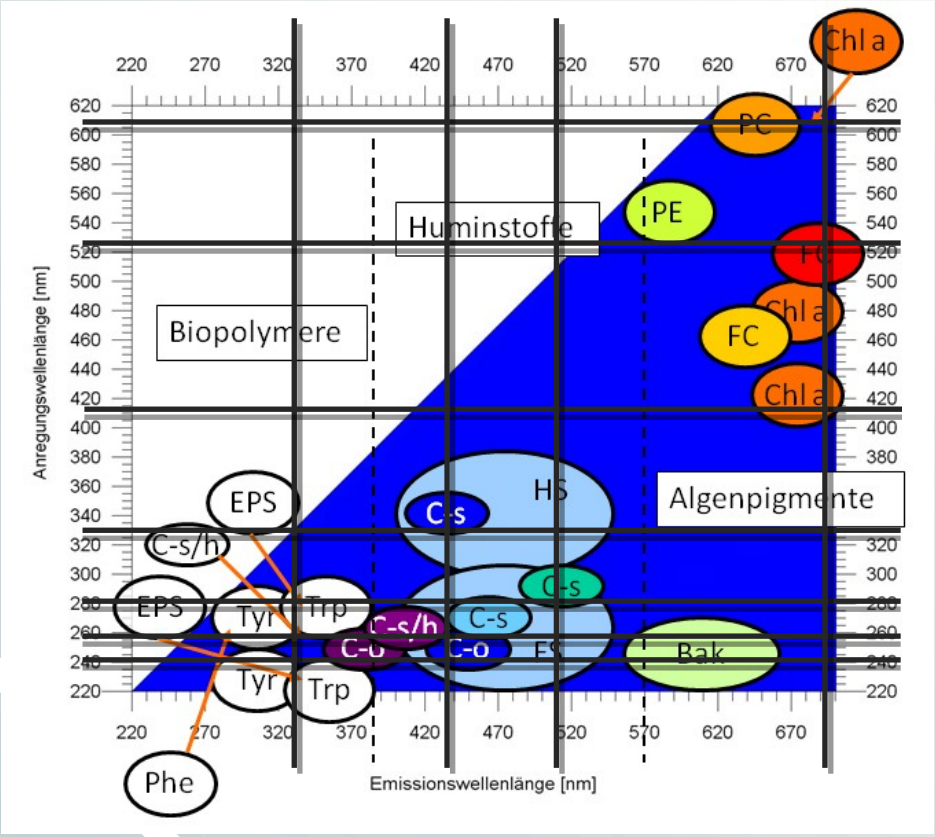
bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de




Fluorescence of organic water content

Rdcording of several emission spectra under variation of excitation (Excitation)
Result is an EEM (Excitation-Emission-Matrix)





bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de




The resulting wavelengths

- Excitation wavelengths

  245nm, 255nm, 280nm, 315nm, 430nm, 505nm, 610nm

-

- Detections wavelengths

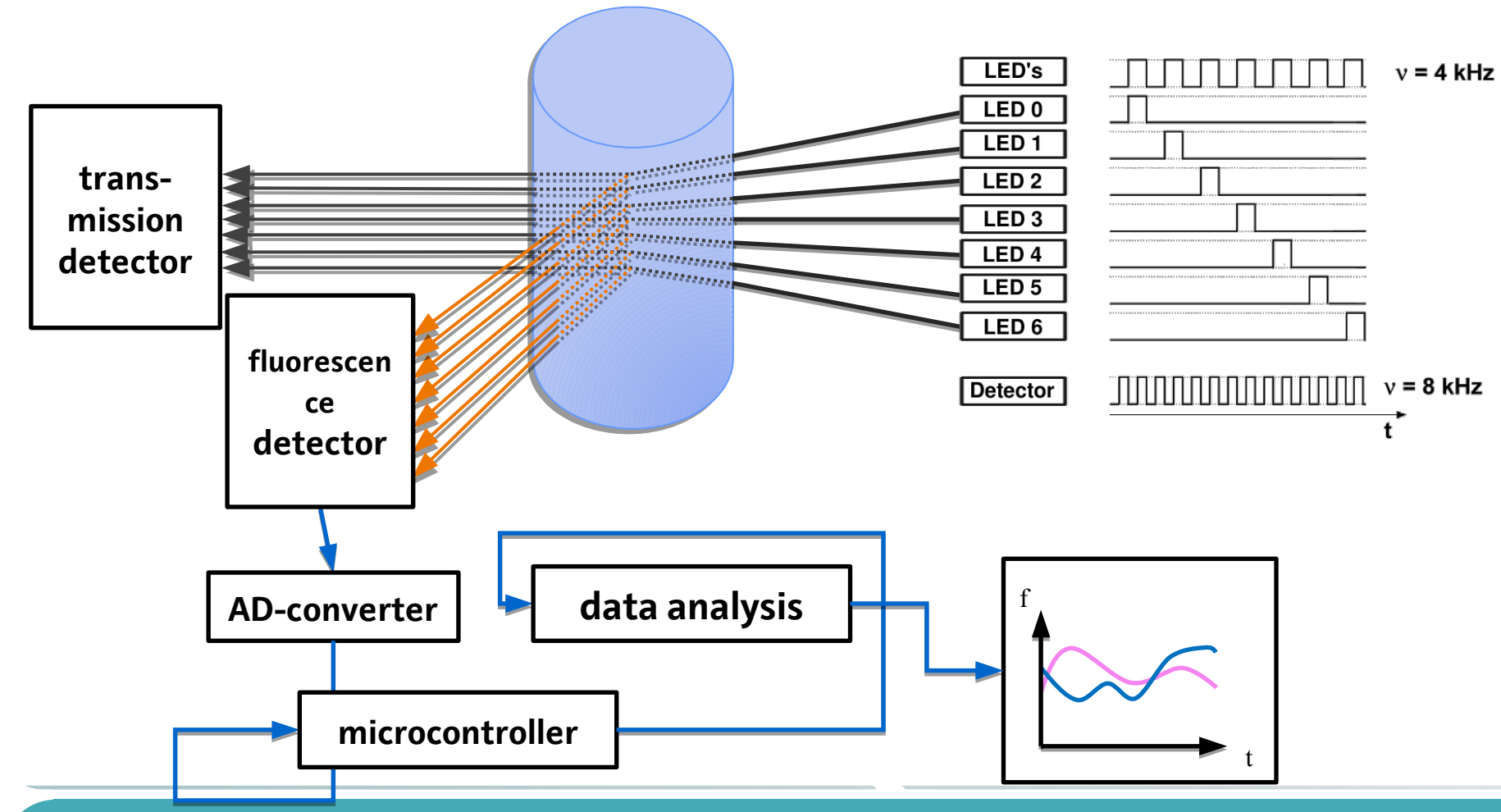
  328nm, 429nm, 511nm, 700nm

-

- Measurement of transmission

bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de

The first approach






Example - Tryptophan

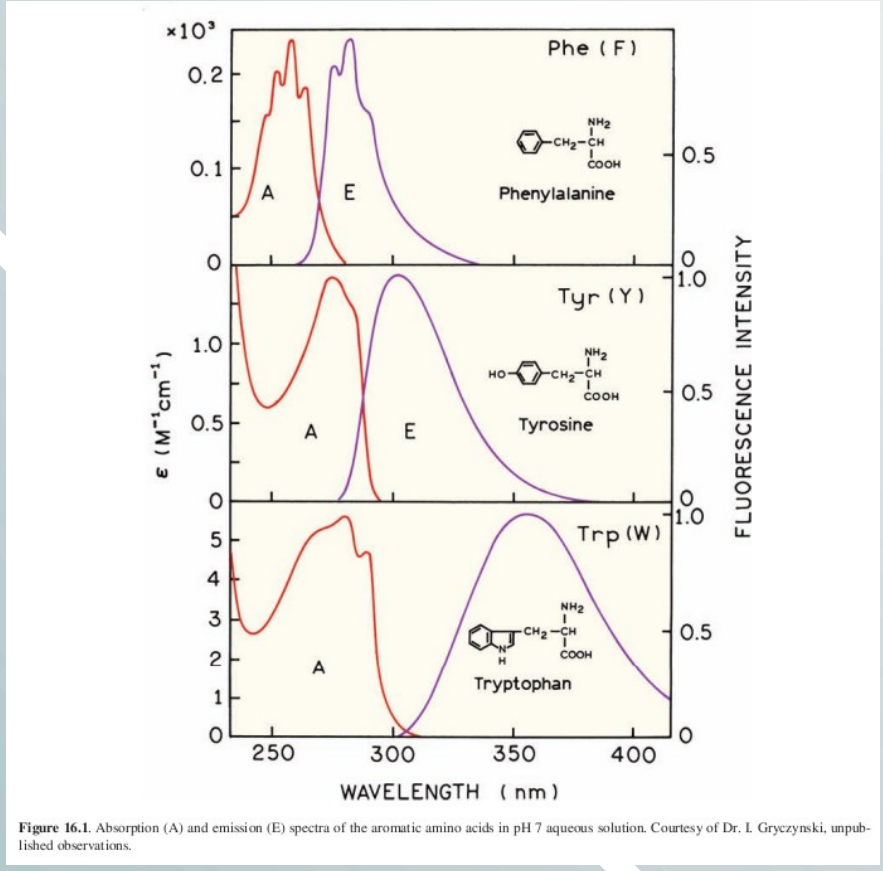
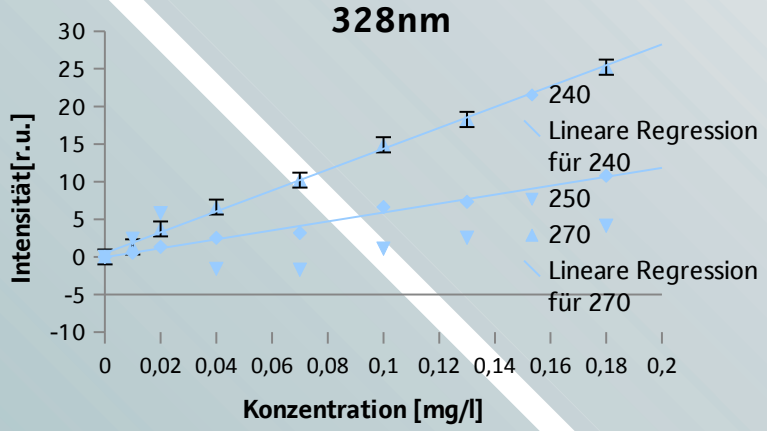


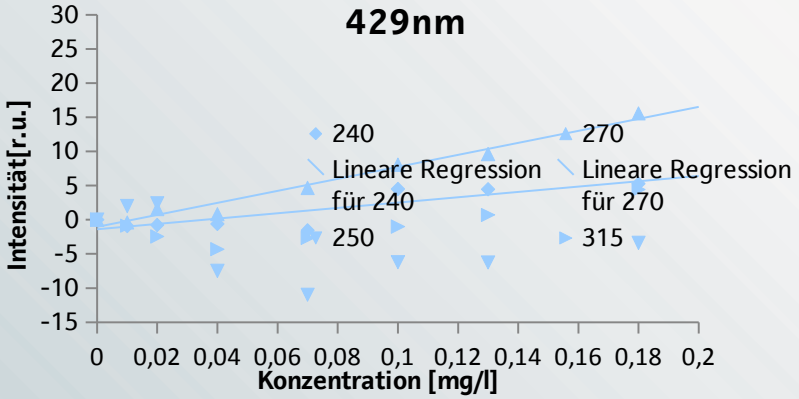
Figure 16.1. Absorption (A) and emission (E) spectra of the aromatic amino acids in pH 7 aqueous solution. Courtesy of Dr. I. Gryczynski, unpublished observations.

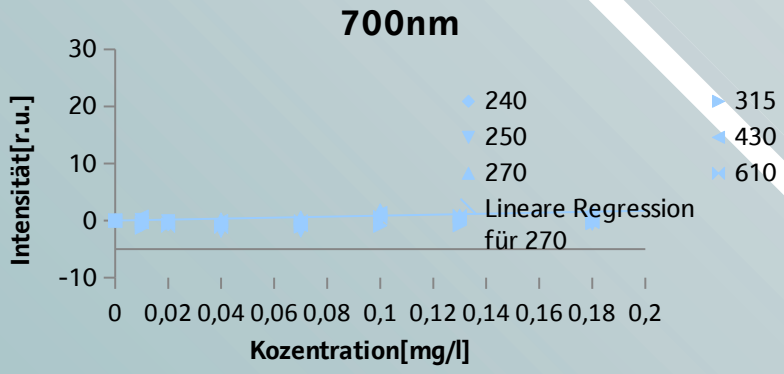
[Lakowicz, Joseph R., *Principles of Fluorescence Spectroscopy,* 4th Printing., 2006]

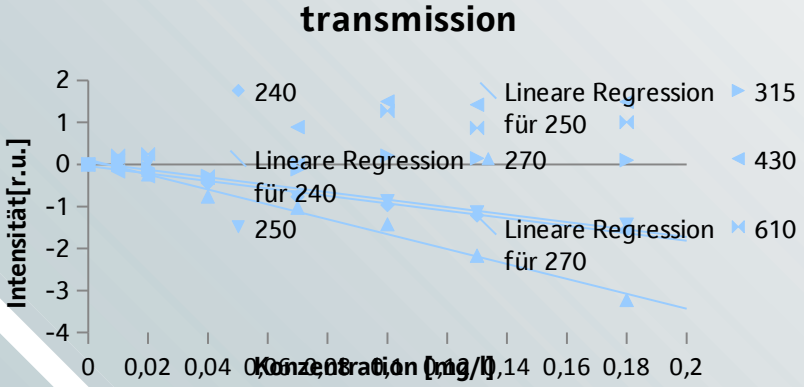



Example – Tryptophan, first prototype







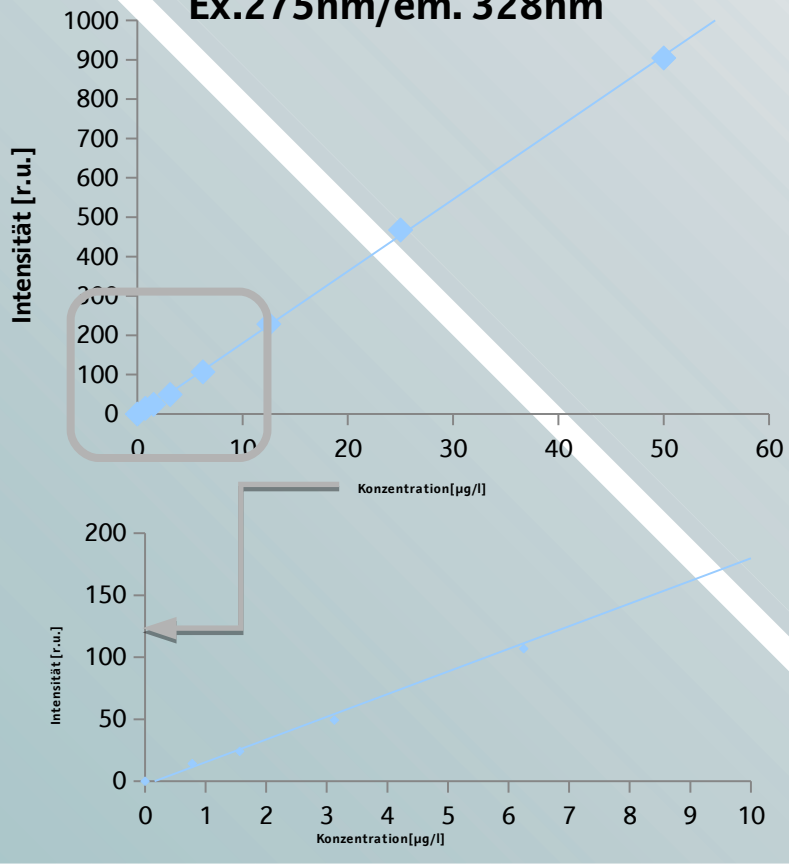


bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de

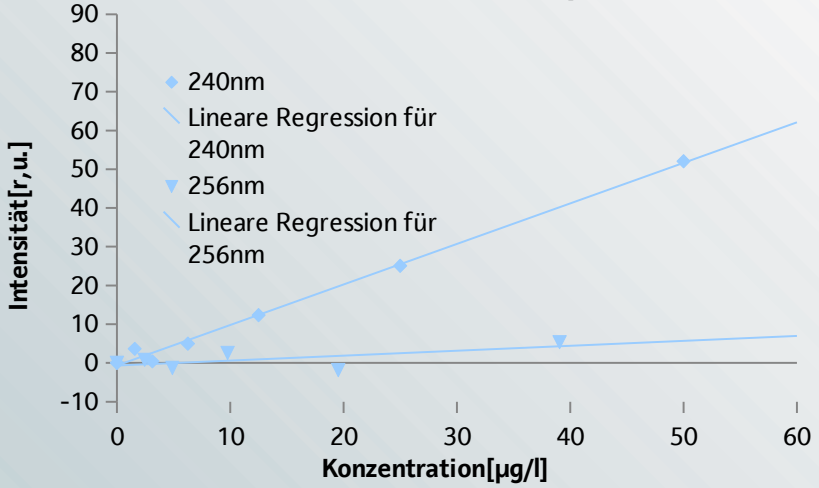



After optimizing the fluoremeter construction with the newest LEDs and detectors/optics

Ex.275nm/em. 328nm



Ex.245nm und 255nm /em. 328nm





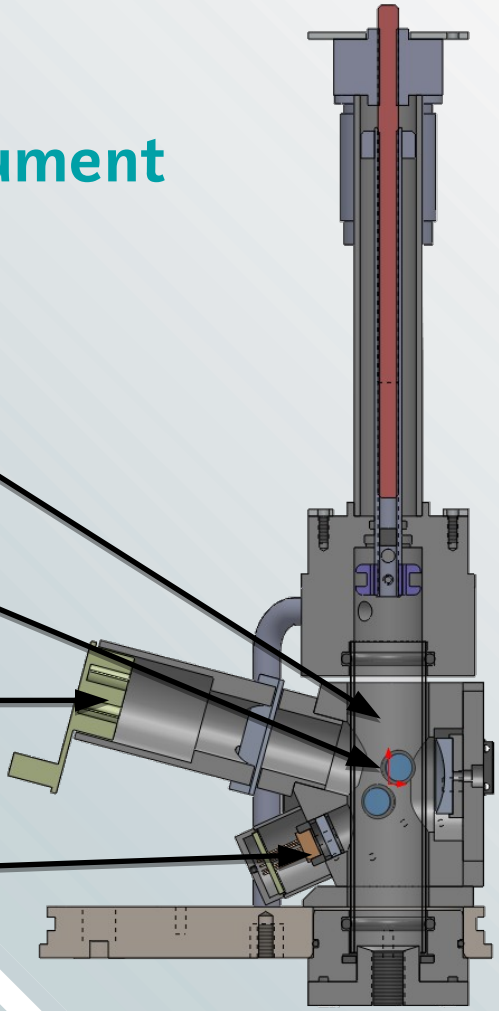

Sketch of the online instrument

The chamber

Fluorescence detectors

Light source

Transmission detector



bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de

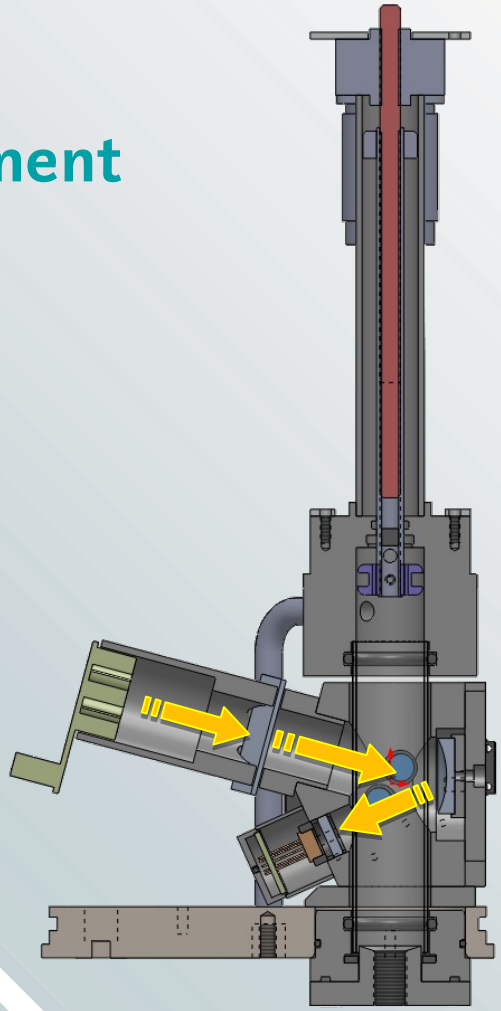



Sketch of the online instrument

- Problems with short light pathway and large detector dimensions

–

The light pathway



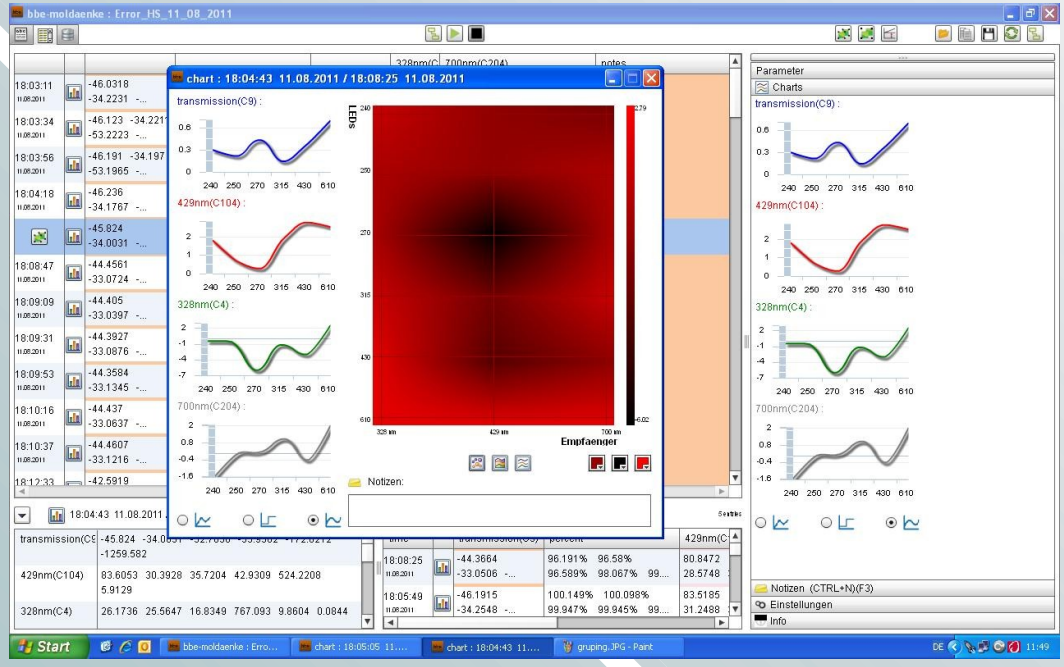
bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de

The online instrument

bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de




First software






Plans for the future

- Finishing the mathematical model
- Further optimization
- Software algorithms and programming
- Test measurements in waterworks

bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de




Thank you for your attention!

bbe Moldaenke; Wildrosenweg 3; 24103 Kiel
Tel:+49 (0) 431 380400; Fax:+49 (0) 431 3804010;
bbe@bbe-moldaenke.de