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FluoroProbe III

The Instrument for Depth Profiles of Microalgae

- Rapid and simple algae monitoring
- Suitable for all surface waters: lakes, reservoirs, rivers and bathing water

What can the FluoroProbe III do?

The FluoroProbe III is a depth profiler for the rapid detection of chlorophyll-a in phytoplankton

FEATURES

- Scientific analysis of water quality
- Qualified measurement of chlorophyll-a
- Simultaneous measurement of different algal classes
- Detection of cyanobacteria
- Depth profiling in real time
- Evaluation of algal blooms
- Detection of phytoplankton populations

Water as the basis of life of all organisms has an essential significance. Increasing anthropogenous pollution of water bodies requires an increase in the observation and assessment of water quality. Chlorophyll-a is significant in the recognition and evaluation of the characteristic features of a water body since phytoplankton is the main component of biomass present in rivers, lakes and the sea.

The FluoroProbe III measures the chlorophyll-a of suspended phytoplankton *in vivo*. Microalgae of different classes and cyanobacteria (cyanophyceae) are part of a complex ecosystem related to zooplankton and higher organisms. Different algal classes (dinoflagellates) and cyanobacteria are known for their production of biotoxins. Since phytoplankton can be found at various depths in a water body, the estimation of the algal content of the water requires a rapid and sensitive profile measurement.

Fluorescence measurements using the FluoroProbe III fulfil these requirements and allow depth profiles to be recorded with the simultaneous analysis of different algal classes, all in real time. The results of the fluorescence spectroscopy of cultured algae and naturally present algae verify the comparability of spectral fluorescence characteristics and serve to evaluate and quantify the chlorophyll-a content of natural populations.

In this way, it is possible to follow the creation and development of algal blooms at high resolutions on the surface as well as at depths. Thus, the FluoroProbe III is the most suitable instrument for the comprehensive investigation of water bodies at phytoplankton level and for the determination of potentially harmful cyanobacteria.

How does the FluoroProbe III measure chlorophyll-a content?

Photosynthesis uses the light energy of the sun to gain and convert energy into energy-rich substances. This process is closely linked to the photosystems of algae and cyanobacteria – with chlorophyll-a playing a central role in the conversion. Fluorescence – i.e. the emission of previously absorbed light – is a natural process. When energised by sunlight or artificial light, unused or superfluous energy is immediately given off. The light-collecting photosystem emits red light at a wavelength of 685 - 700 nm, which is detected by a highly sensitive photomultiplier. At a suitable excitation the emitted fluorescent light is proportional to the chlorophyll-a content of phytoplankton. In additional to chlorophyll-a, algae and cyanobacteria contain accessory pigments for the more effective use of light energy which characteristically influence chlorophyll-a fluorescence.

The use of six different LEDs with excitation wavelengths in the visible range of 370 to 610 nm improves the calculation and enables a distinction of different algal classes. For a constant excitation over the time of deployment, the FluoroProbe III has an integrated LED brightness adjustment. To avoid the influence of ambient light the excitation is pulsed at high frequency (6 KHz) so that only the pulsed and filtered fluorescent response is evaluated. The calculation of the distribution of the amount of chlorophyll-a is performed by using the previously stored fluorescence profiles (fingerprints) of the known algal classes from an algae library.

MEASUREMENT

- Chlorophyll-a fluorescence
- Accessory pigments
- 6 excitation wavelengths
- Brightness regulation of excitation
- High measurement frequency
- Evaluation based on stored algal spectra

> *We regularly check our reservoirs using the FluoroProbe. In contrast to lab methods the FluoroProbe delivers a quick overview of algal content in the reservoirs, and the depth profiles in particular help us to decide at what depth we should extract the raw water.*
>
> ***Anita Nienhüser***
> *Drinking Water Department Head*
> *Bergish Water and Environmental Laboratory of the BTV GmbH*

What are the additional features of the FluoroProbe III?

Additional FluoroProbe III data

Turbidity-causing particles have an influence on the *in vivo* chlorophyll measurement due to light reduction and reflection. The optional transmission measurement with automatic turbidity correction is unique in commercially available chlorophyll measuring instruments and substantially improves the accuracy of the chlorophyll-a measurement. The turbidity values measured are also displayed and stored.
The influence of yellow substances or CDOM, which belong to the group of humic substances, overlaps the fluorescence measurement of chlorophyll particularly at low algal content levels.

FEATURES

- Turbidity measurement and compensation
- CDOM (coloured dissolved organic matter) measurement

FEATURES

- Calibration using algal cultures
- Temperature sensor
- Depth sensor

bbe FluoroProbe III emission lights

This is helped by a determination of yellow substances and an automatic correction. The spectral characteristics of yellow substances are stored in the FluoroProbe III and can be adapted to a specific location when necessary.
This also applies to algae with particular spectral characteristics: a calibration to a new algal class extends the range of application and increases the accuracy of the allocation of the algal classes. The advantage lies in the use of real algae for the calculation of chlorophyll-a values of natural samples.

For algae and cyanobacteria, nutrients and temperature play a significant role. The ambient temperature in the water is determined by the optional temperature sensor on the housing. An exact depth measurement is carried out synchronously using the built-in pressure sensor.

Deployment sites of the FluoroProbe III

OUTDOORS

- Simple operation
- Settings and analysis with bbe++ software
- Bluetooth function for wireless data transfer included
- Submersion depth 0 - 200 m
- Huge data memory
- Cable and cable-free measurements

FluoroProbe III in the field

Using the FluoroProbe III in waterbodies, whether in rivers, reservoirs or lakes, is easy and simple with the bbe++ software. The software runs on any current Windows PC and communicates via a USB cable or the integrated Bluetooth function of the 'DPA'. This allows data to be displayed on the end device in real time. bbe++ controls all the measurements, the data transfer and the parameterisation. A clear overview allows simple measurement: after measuring the air pressure at the surface (key) for depth measurement, START and STOP signal the beginning and end of a measurement. The FluoroProbe III can be lowered into the water by hand or by using a winch – at a recommended speed of approximately 30 cm/sec. The measurement frequency is up to 4 measurements/second. Maximum depth with cable is 100 m. The internal memory can store up to 10 million datasets.

The FluoroProbe III is readily deployable without cable by use of an autostart plug. By attaching the plug, the measurement is started and continues until the plug is removed. Via Bluetooth connection or the USB cable the data can be transferred to a PC or directly be downloaded to the USB flash drive supplied. The depth range of the FluoroProbe III is down to 200 m. The internal battery supplies the FluoroProbe III for extended underwater operation without an external powersource. For longer operation bbe recommends the setting for sleep mode with low power usage and an optional wiper for the removal of biofilm from the optics. A steel cage has proved useful against mechanical damage during operation from the side of a ship or in rough environments.

Using the FluoroProbe III in the laboratory

The FluoroProbe III can also be deployed in the laboratory by using the specially developed Workstation25 as a stand for the instrument. The measurements of chlorophyll-a are performed in a 25 ml special cuvette vmade of optical glass. The optional stirrer motor ensures a homogenous distribution of the sample so that the algae (in particular diatoms) cannot settle. Ambient light is excluded from the optics by a specially designed cover. A test cuvette is also available for function testing.
The FluoroProbe III can also be deployed in pipe systems using a specially designed Flow-Through Unit (inlet and outlet connections). The sample water can be transported using an external pump.

Site of application – what is performed?

The FluoroProbe III can be used in many different applications: e.g. in the field of limnology, lakes and rivers are sampled. Focus is given to ecological questions, in particular changes and status evaluation. Investigations can also be carried out in accordance with the EU Water Framework Directive. Moreover, for quality control the FluoroProbe III is also used in reservoirs, particularly for an analysis of potentially harmful cyanobacteria *Microcystis aeruginosa* and *Planktothrix rubescens*. In this case, a surface water sample is often insufficient since the cyanobacteria prefer particular depths according to the time of year. The aim is the prediction of the dynamic of cyanobacteria blooms. In reservoirs, this concerns the avoidance of cyanotoxins biotoxins. Drinking water producers in Japan, for example, use the FluoroProbe III integrated in a pipe system. Research trips to the Caribbean and the Antarctic are evidence of the manifold uses of the FluoroProbe III. Nearshore areas are also used by aquaculture companies in the breeding of seafish. The use of feed and the formation of free nutrients promotes substantial growth of algae with all its undesired consequences. The FluoroProbe III documents the changes precisely via a high data density.

OUTDOORS

- Autostart plug
- Increased depth range
- Energy control
- Long-term measurement

ADDITIONAL USES

- Lab use with the Workstation25 and cuvette
- Test cuvette for function testing
- Flow-through measurement

USERS

- Reservoir operators
- Aquaculture farms
- Drinking water producers
- Assessors
- Ecologists, Limnologists
- Oceanographers

The spectral analysis of algae

Chlorophyll-a content from algae and cyanobacteria

- Reference spectra
- Fit procedure

The „Data and Power Adapter“ with accessories incl. Bluetooth-function

BBE++ SOFTWARE

- Database
- Graphic and table representation
- Macro settings
- Basic and expert modes
- Re-calculation
- Data export

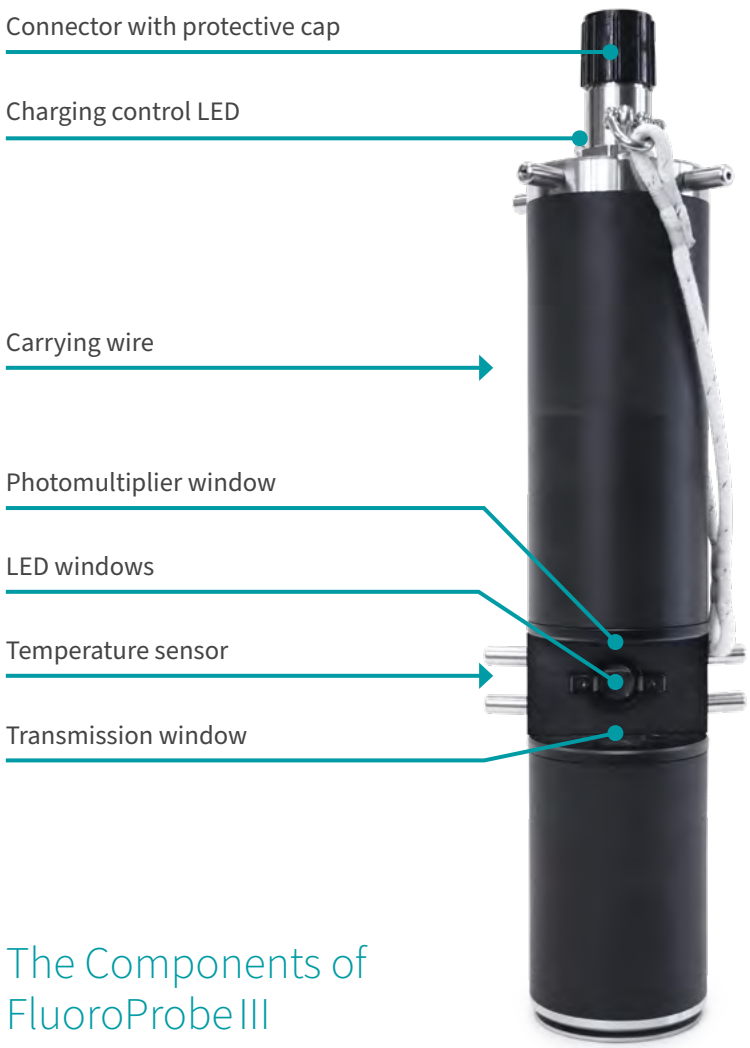
How is the chlorophyll-a calculated?

The FluoroProbe III is prepared for immediate chlorophyll determination by factory calibration using standard algae. This is performed using a special spectrofluorometer (bbe ALA) which has been calibrated using HPLC analyses of extracted algal pigments. HPLC analyses are carried out by external laboratories. These reference spectra of the algae used for the determination of the chlorophyll-a are stored in the FluoroProbe III. Each algal class has a characteristic fluorescence spectrum (fingerprint) referring to the chlorophyll content present with regard to form and intensity. Based on the linear combination of the fluorescence signals created by the algal fluorescence of the sample algae, the measurement values obtained are compared with the reference data and distributed optimally across the different algal classes by means of a fit procedure. The total chlorophyll-a content results from the sum of the chlorophyll-a of the individual algal classes.

The software allows the user to perform additional calculations by activating or deactivating different algal classes in order to improve the adaptation if necessary. Different reference data from yellow substances can also be applied to the calculation.

The FluoroProbe III uses the supplied bbe++ software and stores the data in a database. bbe++ takes care of data transmission as well as the display of the results in graphs and tables. Macros enable easy pre-selection of suitable display options. The FluoroProbe III can also be operated and controlled in online mode using the bbe++ software. Access is organised in a clear basic and a complex expert mode with all the possibilities of such advanced software. The basic mode comprises all essential functions for operation in the field and the laboratory. The expert mode allows optimisation of the algal classes via a re-calculation using additional fingerprints. The bbe++ software allows the problem-free export of data to other programmes (e.g. Excel).

Components, scope of delivery and maintenance



The Components of FluoroProbe III

SCOPE OF DELIVERY

- The "FluoroProbe III"
- Charger
- DPA with USB port for data exchange
- Protective cap
- Light screen
- Software & Manual
- USB-C cable incl. USB-A adapter

Optional:

- Measuring cables of 10, 20, 30, 50, 100 m
- Cable drum (for up to 100m cable)
- Autostart plug
- Workstation25 with cuvette and stirrer
- Flow-Through unit
- Wiper
- Steel Cage

Hints on care and calibration

The FluoroProbe III is almost completely maintenance-free. As with all optical instruments the optical path must be kept clean. Rinsing the optics with clean water is sufficient. In case of biofilm, bbe recommends manual cleaning or the use of an optional wiper which cleans the surface periodically between the measurements.

Re-calibration of the FluoroProbe III is recommended every two years. This can be performed in the calibration laboratory at bbe using standardised algal cultures. A technical inspection which can prevent errors during subsequent field operation can also be carried out at the same time.
For long-term operation at 1 measurement/sec the maximum operation time is 10 hours. If measurements are carried out once per day, the FluoroProbe III is deployable around 30 days. The maximum charging time is approx. 8 hours.

MAINTENANCE & SERVICE

- Cleaning
- Calibration, Inspection
- Operation time
- Charging

ADVANTAGES

- Replaces a considerable amount of time-intensive laboratory analysis
- No sample preparation needed
- Perfect addition to microscopy
- Real-time analysis of phytoplankton
- High measuring speed
- Turbidity correction
- Yellow substances correction
- Calibration using algal cultures
- Use of custom spectra
- Internal data logger
- Internal power supply, rechargeable
- Wide-ranging accessories

FluoroProbe III with Hydro-Wiper after weeks of operation

Technical Details of the FluoroProbe III

DESCRIPTION	VALUES
Measurands	total chlorophyll [µg chl-a/l], green algae [µg chl-a/l], cyanobacteria [µg chl-a/l], diatoms [µg chl-a/l], cryptophyceae [µg chl-a/l], yellow substances correction, water temperature (optional), transmission (optional), depth
Measuring range	0 - 500 µg chlorophyll-a/l
Measurement principle	spectral fluorometry
Resolution	0.01 µg chlorophyll-a/l
Transmission	0 - 100 %
Water temperature	-2 to 40°C
Housing material	reinforced plastic / V4A Steel
Weight	6.4 kg (7.2 kg incl. light screen, in water 4.2 kg)
Dimensions (H x Ø)	450 x 140 mm
Voltage	24 V
Battery capacity	3900 mAh
Operating time	continuous operation approx. 10 hrs; interval approx . 30 days
Memory capacity	2 GB memory card - 10 million datasets
Interface	USB
Maximum depth	0 - 100 m (standard) 0 - 200 m (extended)
Options	cuvette holder (Workstation25), temperature / transmission measurement, measuring cables: 3 - 100 m, Hydro-Wiper unit

Do you have any questions? Please contact us!

Your local representative

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