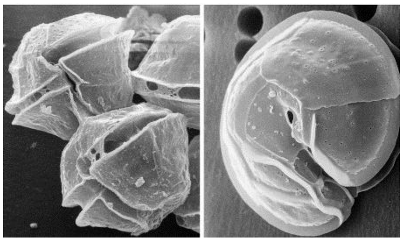
Early warning system for toxic algae species

TU Graz – Graz University of Technology

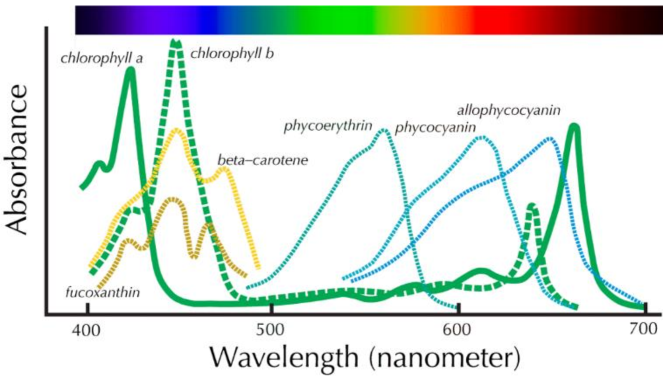
IDRONAUT S.r.l. ITALY

Motivation



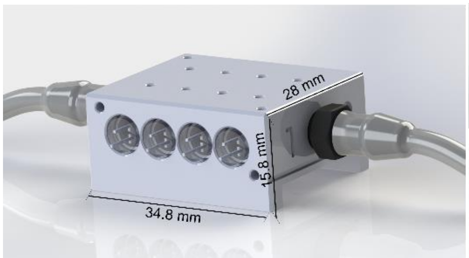
Although algae are sensitive indicators for changing environmental conditions, they may have an adverse impact on the ecosystem, when they form harmful blooms during spring and autumn. Not only that (shell)fish products contaminated with harmful algae blooms are dangerous for humans and marine life, they cause a huge economic loss for the fish farming industry and tourism.[1] Fish farms suffer under the economic loss, when they have to close their aqua farms for a long period and in touristic regions, the increasing water temperature favours tropical, sometimes toxic algae species, which can cause severe poisoning of humans by inhalation of aerosols containing the toxic species. Therefore it is of high interest to have an early warning system for such algae blooms in order to allow a quick reaction of authorities using appropriate measures.

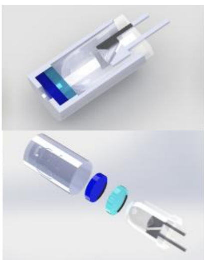
Algae detection based on their pigmentation



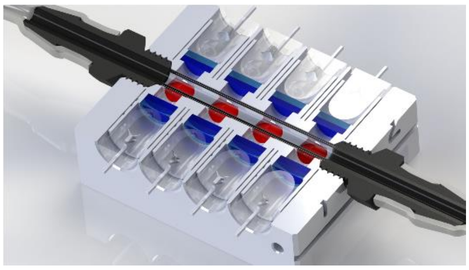
To maintain their photosynthetic processes, algae harvest daylight efficiently using a cascade of pigments throughout the visible range. These pigments mostly transfer their energy to Chlorophyll a in the reaction center, which then acts as an electron pump for photosynthesis. Since the relative pigmentation is characteristic for an algae class, algae species can conveniently be characterized and differenced by their excitation spectra, while only a few emission wavelengths are required.

Algae detection module





Peak wavelength λ_p [nm]	Half width $\Delta\lambda$ [nm]
380	10
401	15
429	20
452	25
470	20
522	30
545	30
640	20



Designed as a miniaturized flow-cytometer operating in a modular way, our detection unit contains up to 8 different excitation wavelengths and 4 emission channels. Due to the miniaturised design, the sensitivity and

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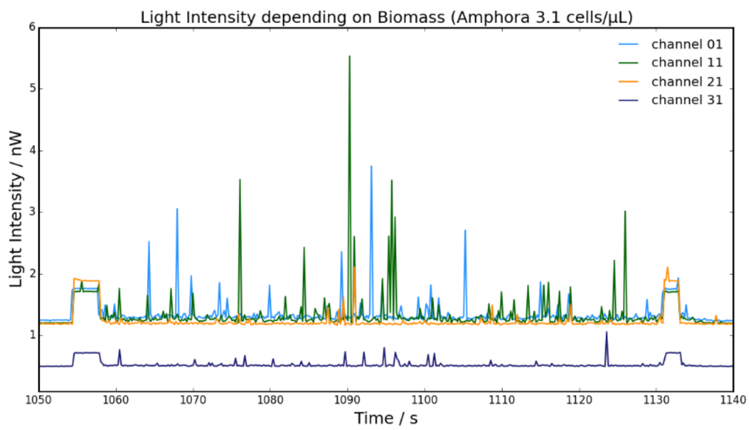
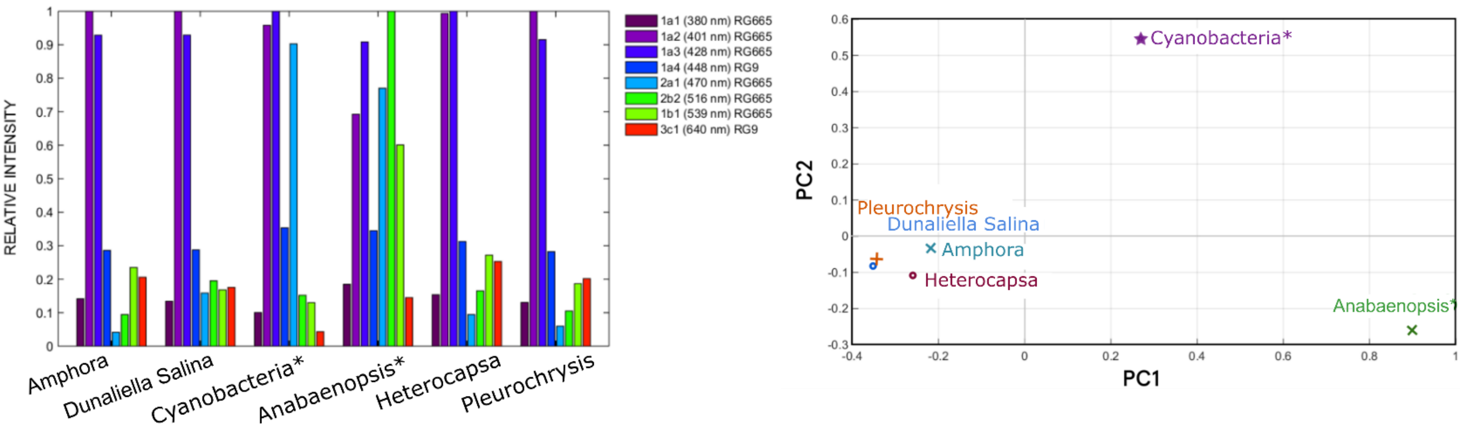
selectivity are increased, whereas background effects are reduced. First measurements were promising that we are able to detect single cell events since we obtain signals down to a concentration of about 2 cells per 5 microliters illuminated volume.



Time drive plot of amphora sample illustrating cell events passing through the detection unit.

For the quantification of the average cell density, the detection unit counts the cells passing through the system for a defined period of time. Using multivariate data analysis, we were able to classify and identify several algae classes according to their relative pigmentation enabling an in-situ analysis. For the moment, we are able to separate the most common toxin producing cyanobacteria from other algae classes.



*Relative pigment composition of different algae and cyanobacteria (marked with *) (left) and resulting sore plot after analyzing the data by the means of the principal component analysis. Both cyanobacteria were separated clearly from the rest (right).*

Application

The basis module is designed as a compact and flexible system, which is first implemented in the SCHeMA project (FP7-Ocean 2013.2, Grant Agreement no. 614002). An application to other case studies and the combination with other optical sensors such as pH, oxygen or CO_2 is also possible.

References

[1] D.M. Anderson et al. *Monitoring and Management Strategies for Harmful Algal Blooms in Coastal Waters*. #201-MR-01.1 59. Paris: APEC - Asia Pacific Economic Program, Singapore, and Intergovernmental Oceanographic Commission, 2001.

Zieger S. E., @ email: *zieger@tugraz.at*, Stremayrgasse 9/II, 8010 Graz (Austria)