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Water pollution sensor using microalgae and xurography-based microfluidic chips

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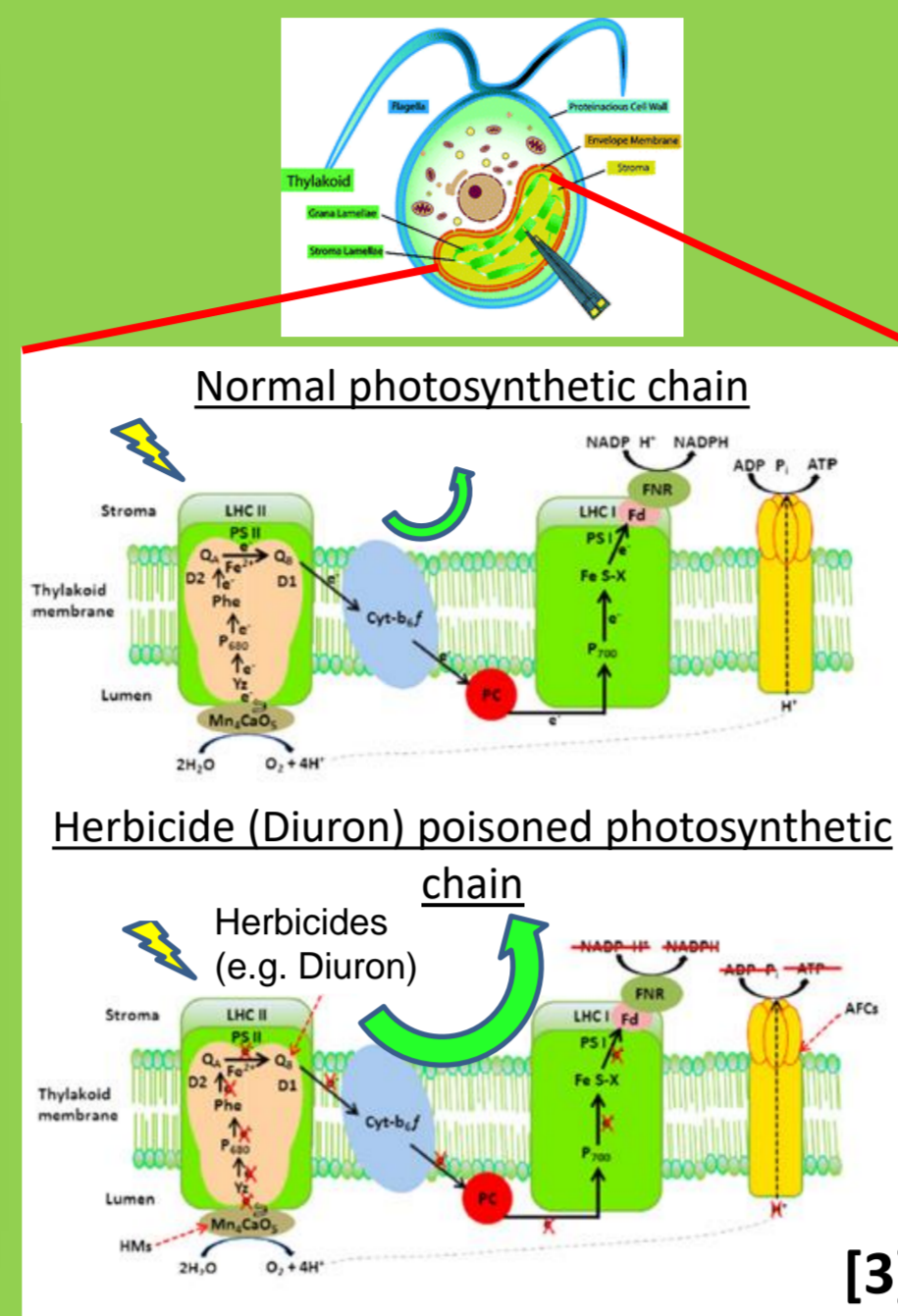


Introduction

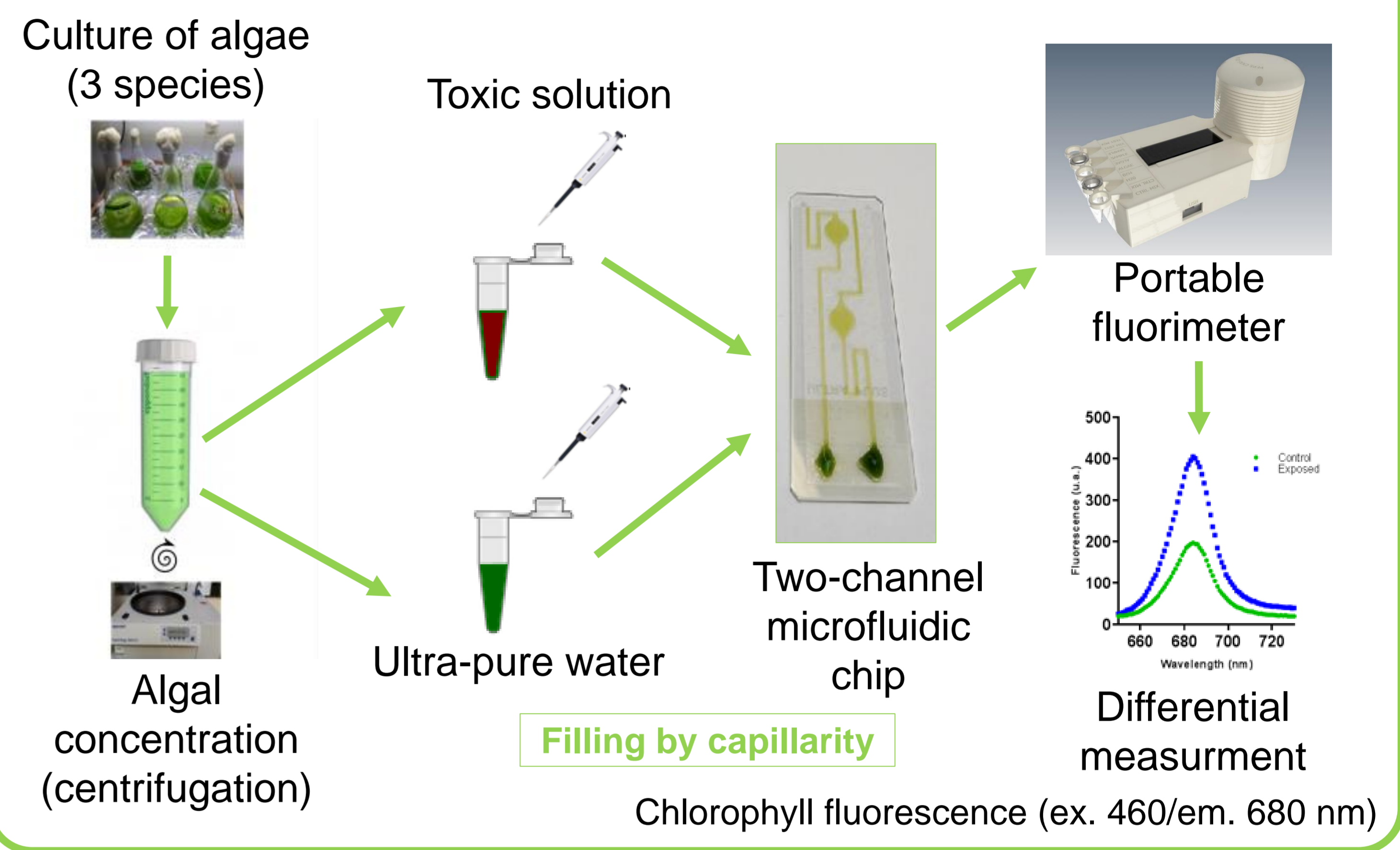
- Urban wastewaters (e.g. stormwaters): a source of many ecotoxic micropollutants for aquatic ecosystems [1].
- Algal biosensors are very promising tools for the measurement of potential toxic discharges, using photosynthetic activity disturbance (chlorophyll fluorescence) [2].
- Current barriers to their effective use: algal immobilization (e.g. with hydrogels, that lead to a low sensitivity and problems of reduced cell viability), variability of response and transportation on field (pumps).
- Microfluidics and xurography are very useful to overcome these technical problems (good volume control, no immobilization, miniaturization, low cost).

Objective

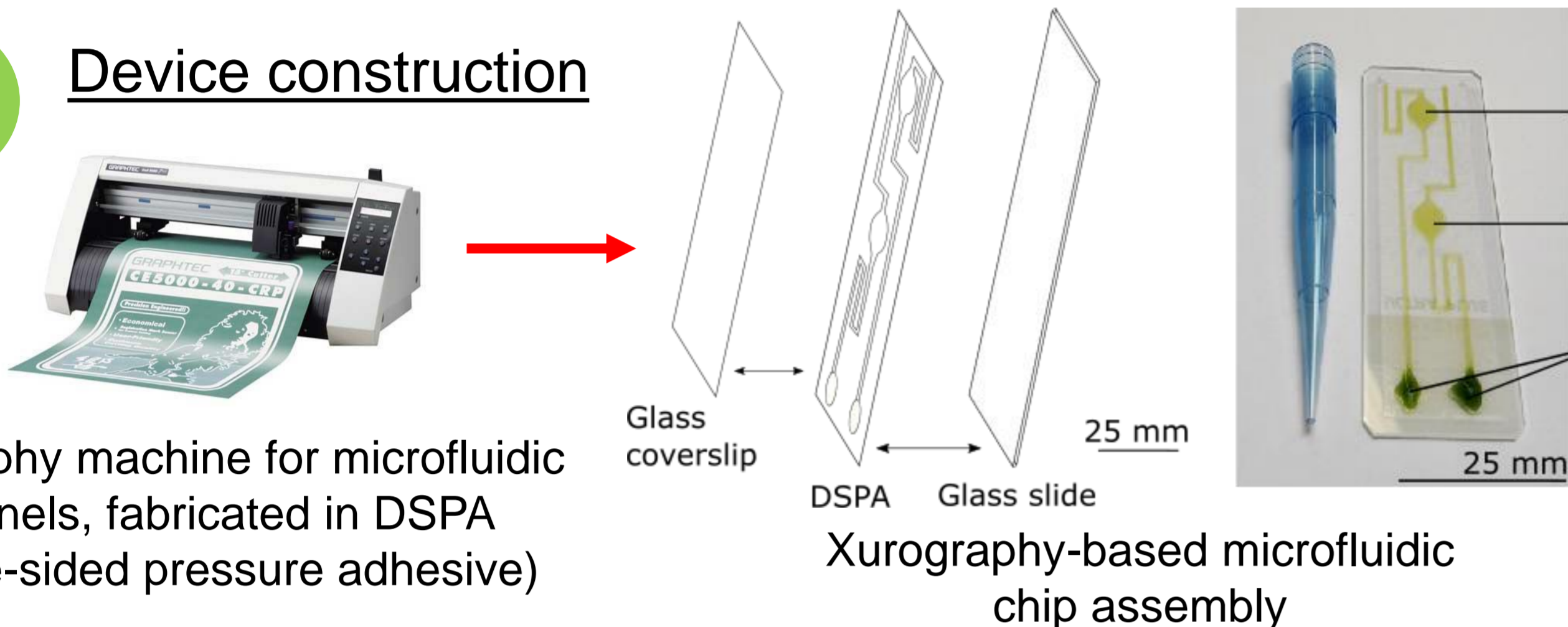
To develop (with a model pesticide, Diuron) an multi-algal biosensor employing ready-to-use xurography-based microfluidic chips and a dedicated fluorescence analysis system; and to apply this tool for the detection of toxic urban wastewater samples.



General principle of the sensor



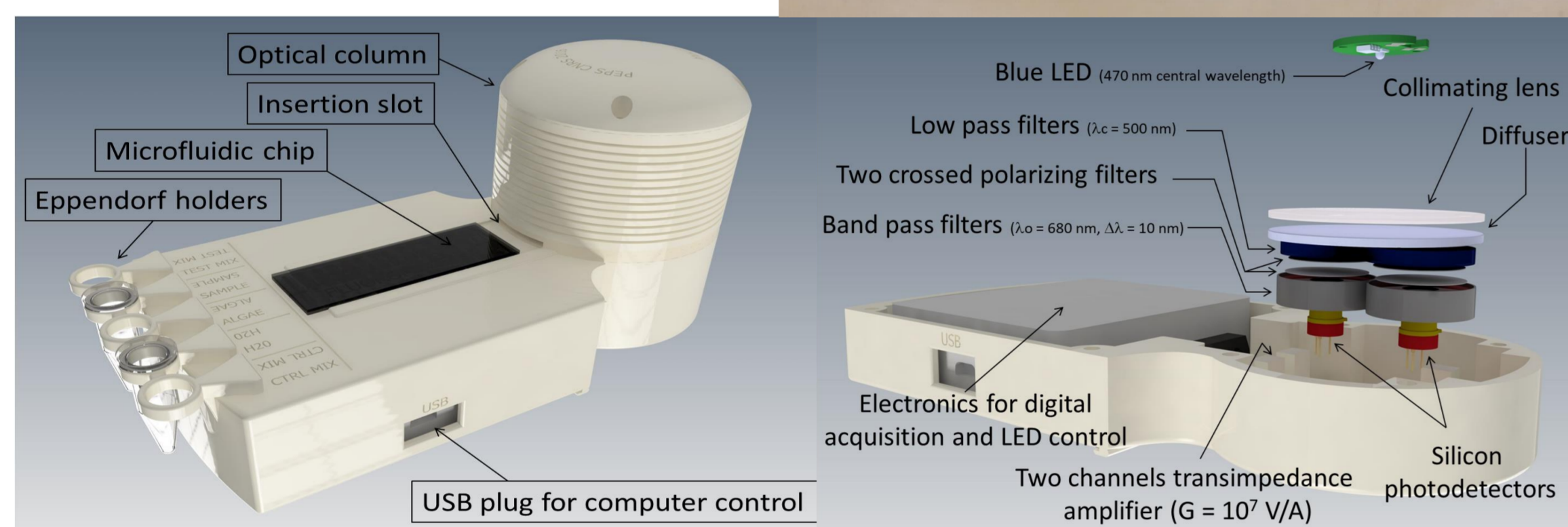
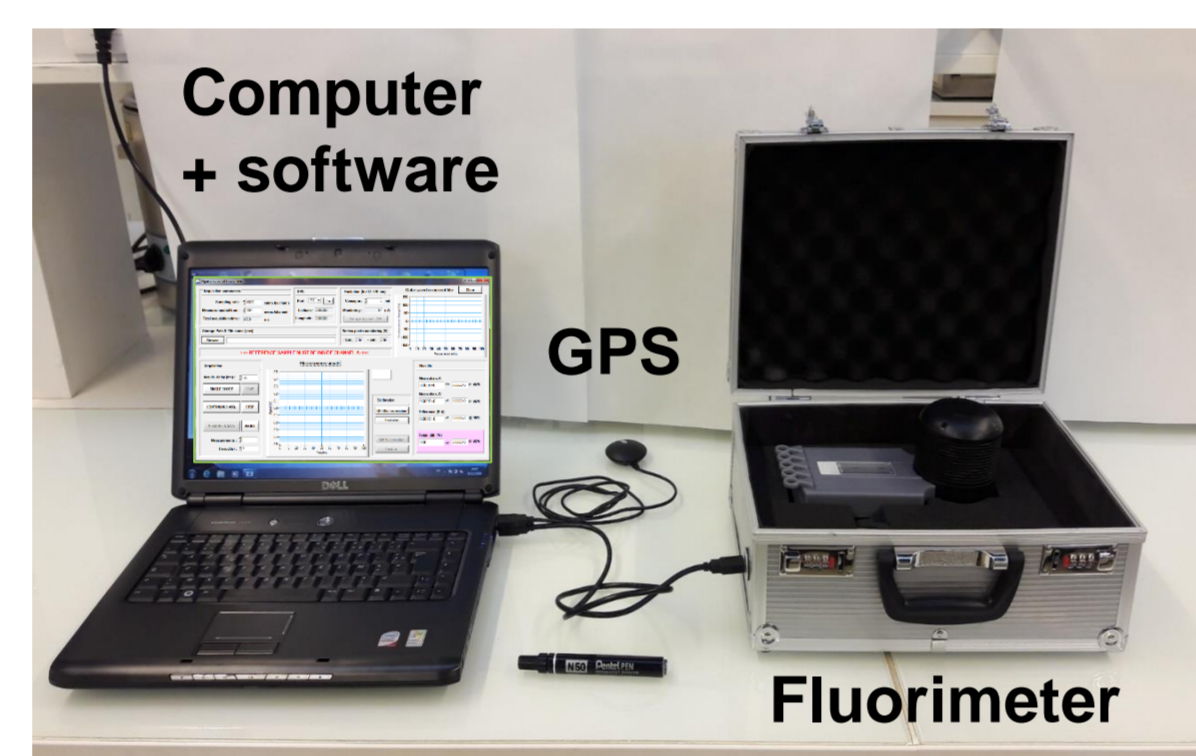
1 Device construction



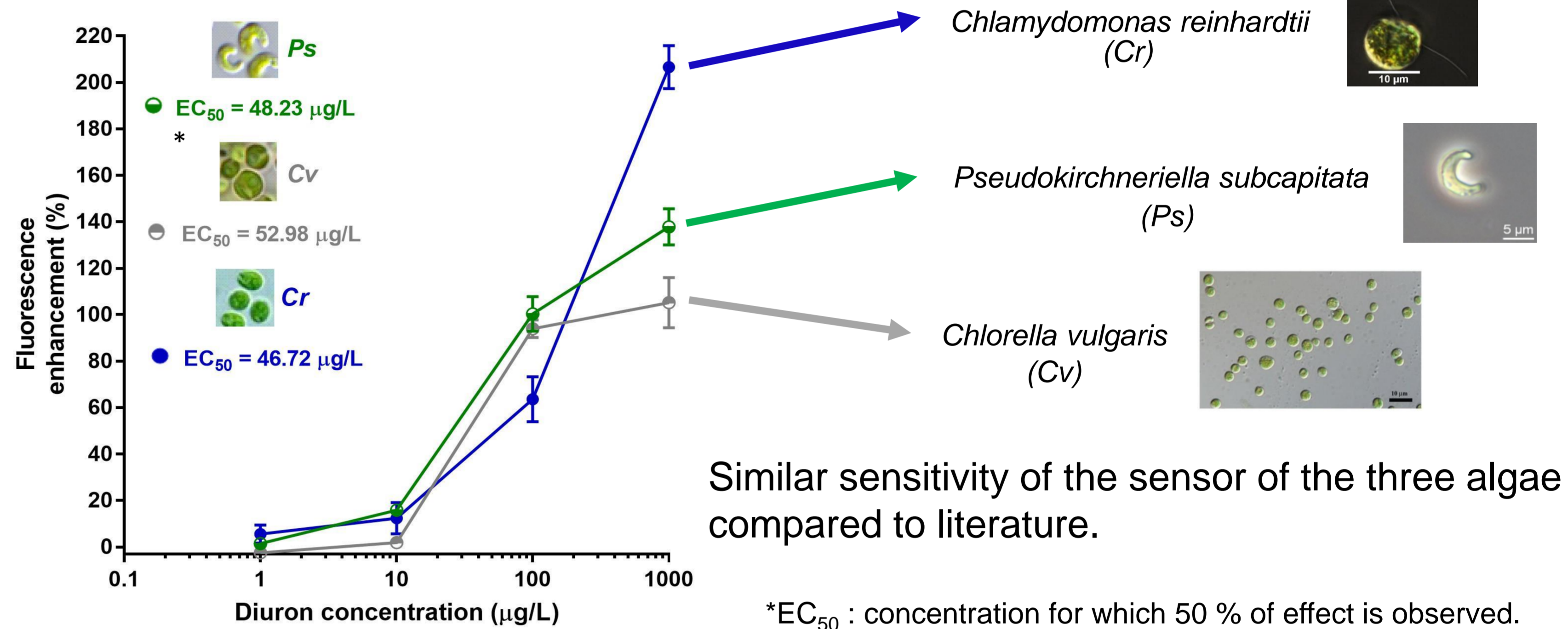
Xurography machine for microfluidic channels, fabricated in DSPA (double-sided pressure adhesive)

Glass coverslip
 DSPA
 Glass slide
 Xurography-based microfluidic chip assembly

Fluorimeter device dedicated to microfluidic chip analysis



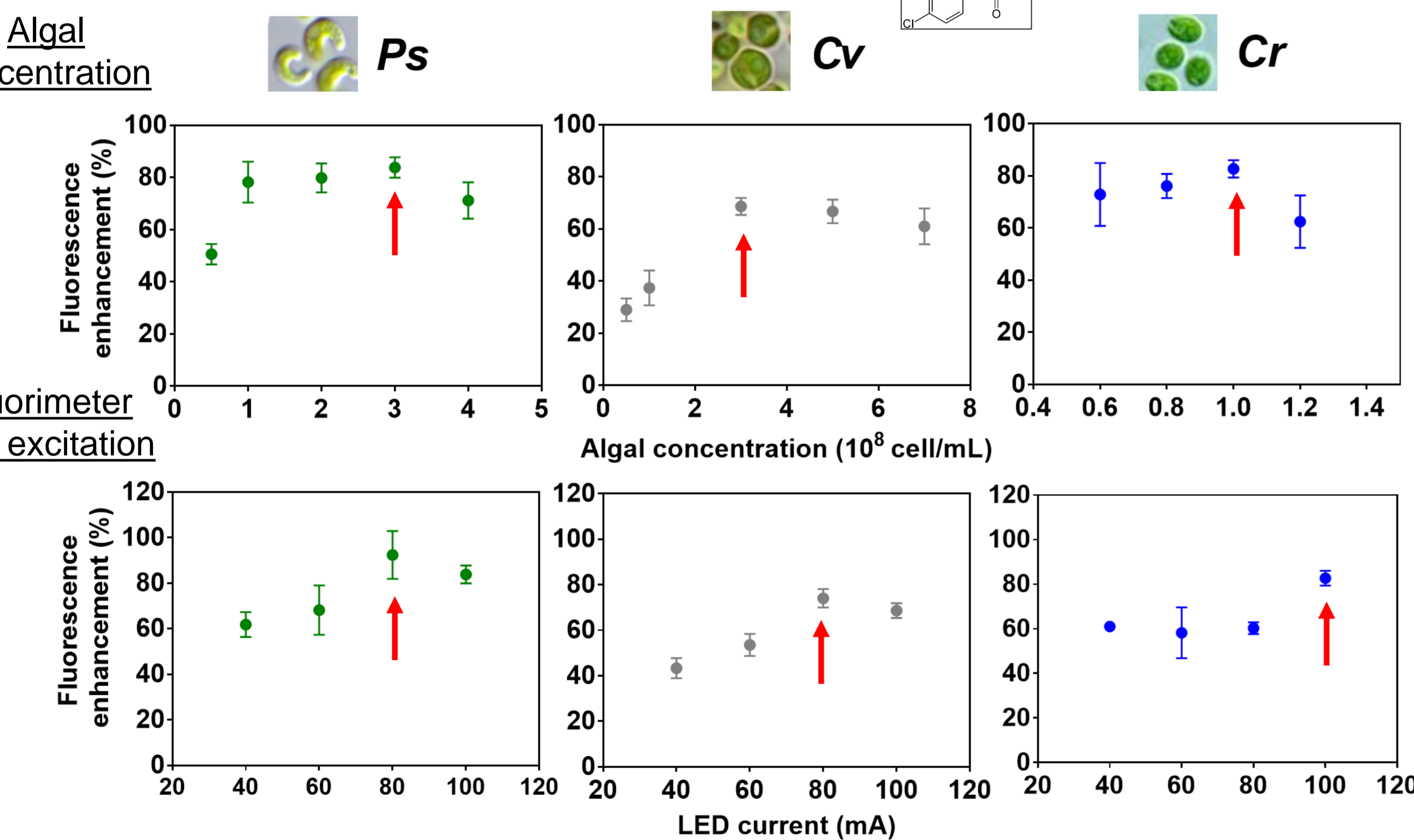
3 Sensor sensitivity evaluation using a model pesticide (Diuron)



Similar sensitivity of the sensor of the three algae compared to literature.

*EC₅₀ : concentration for which 50 % of effect is observed.

2 Sensor sensitivity parameter optimization using a model pesticide (Diuron)



Optimization of these parameters with an exposure time of the algae to the Diuron of 20 (Ps), 5 (Cv) and 10 (Cr) minutes respectively. Application of the sensor (3 and 4) with the same conditions.

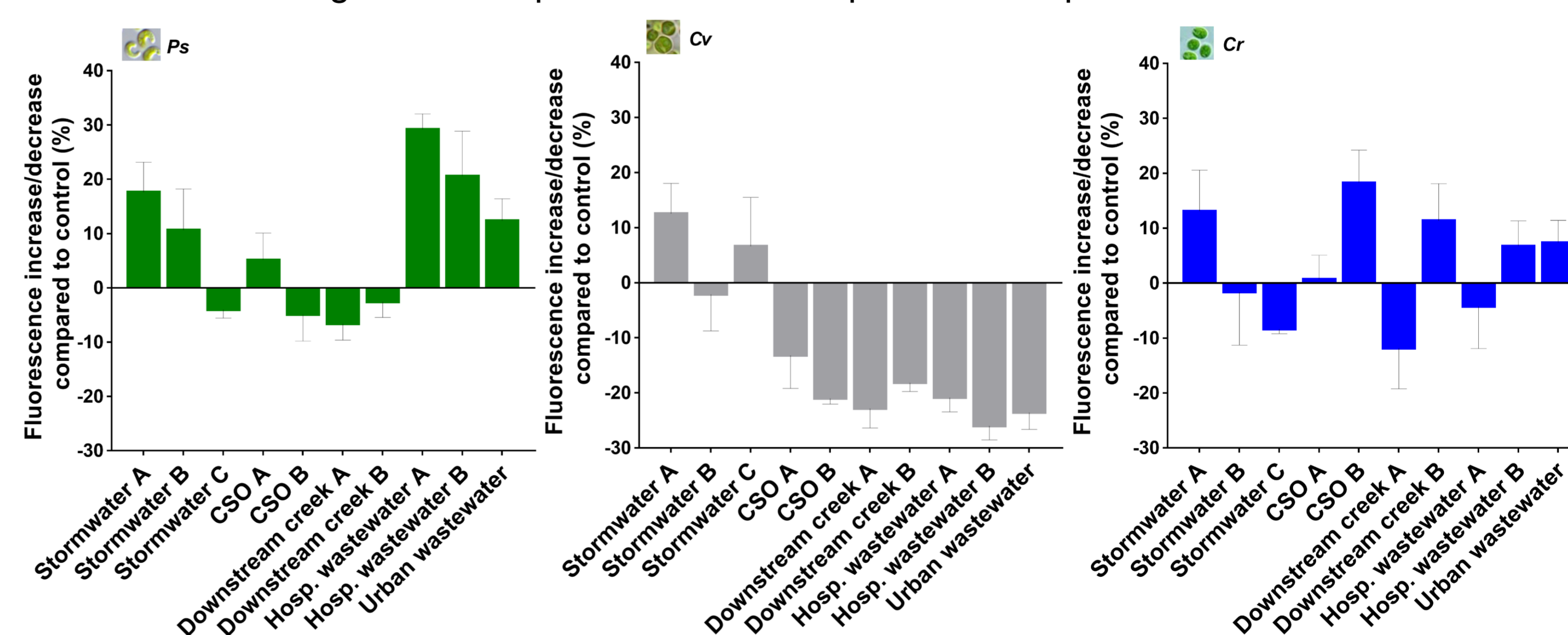
4 Application of the biosensor to urban discharges toxicity evaluation

Application to 10 urban discharges toxicity evaluation : 3 stormwaters, 2 combined sewer overflows (CSO), 2 contaminated suburban creeks, 2 hospital and 1 urban wastewater treatment plant influents.



Main observations :

- A different response of the three algae to the 10 samples tested.
 - Potential for using multiple algae strains
- A more significant response to the most polluted samples.



Conclusion

- We developed here a ready-to-use water toxic pollution biosensor :
 - Low cost
 - Fast and easy to construct
 - Reliable
 - Portable
 - Easy-to-use
 - Sensitive
 - Fast to respond
- The potential of microfluidic and xurography for algal sensor construction was demonstrated.
- The use of multiple algae strains is essential to develop an effective tool.

Further Work

- To develop a multi-channel (for replicates) sensor using more complex chips.
- To avoid preliminary algal concentration using lab-on-a-disc technology.
- To calibrate the sensor with many different kinds of waters/discharges.

References

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- [2] Védrine, C., Leclerc, J. C., Durrieu, C., & Tran-Minh, C. (2003). Optical whole-cell biosensor using *Chlorella vulgaris* designed for monitoring herbicides. *Biosensors and Bioelectronics*, 18(4), 457-463.
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