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CLUB-Poster

Poster 38: Scalable Algae Cultivation as Proof-of-Concept for a Floating Light Ball Reactor (FLBR®)

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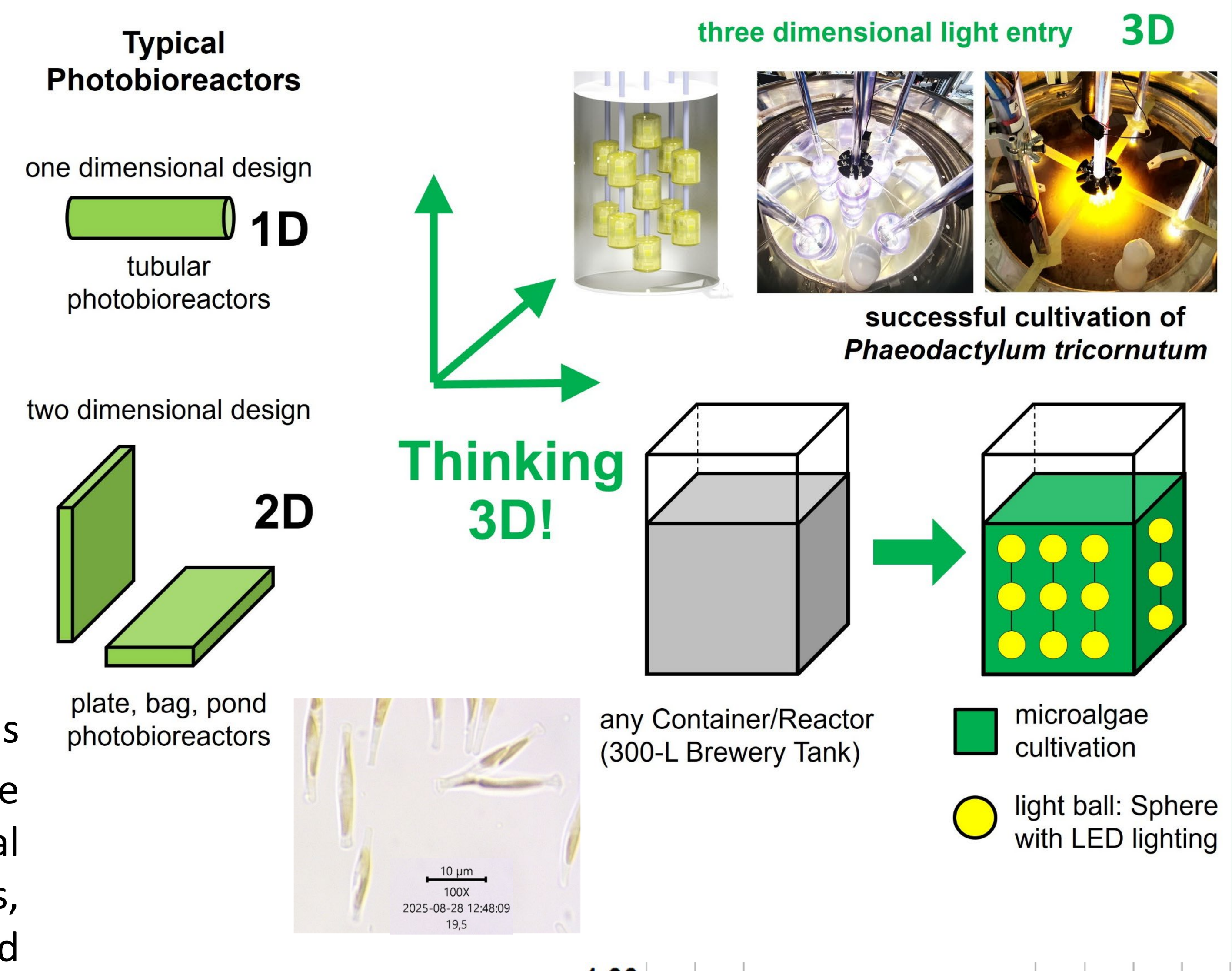
Significance:

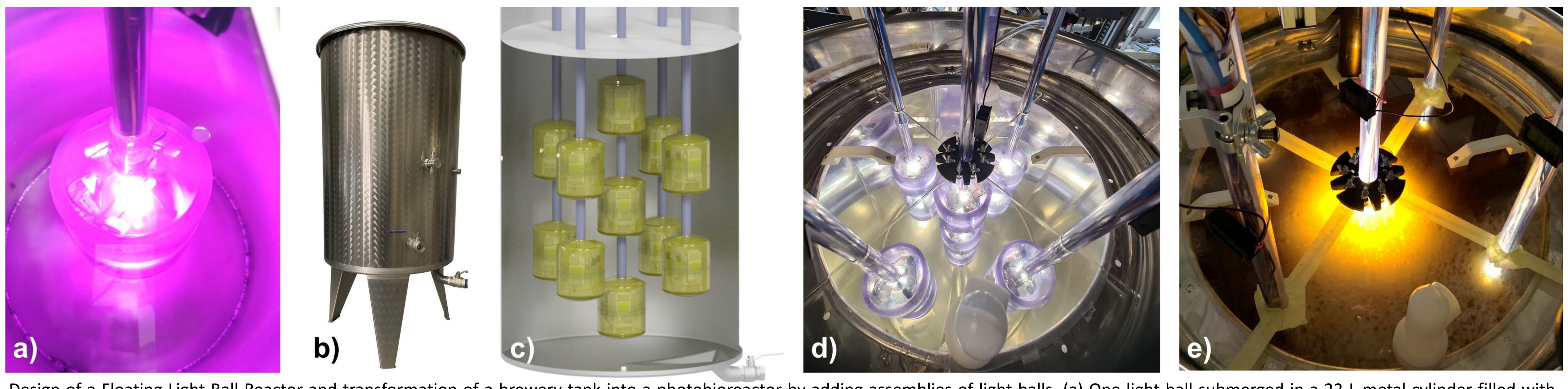
- New photobioreactor concept with internal 3D light entry [1, 2]
- Modular FLBR® design for scalable, sunlight-independent algae cultivation in any container
- Adjustable illumination area, light intensity and light spectrum
- Flexible platform for controlled photon delivery in liquid media
- Potential transfer to photochemical & photocatalysis
- Economically scalable to any size
- Conversion of CO_2 into valuable biochemicals and sustainable feedstocks[4]

Floating Light Ball Reactor (FLBR®)



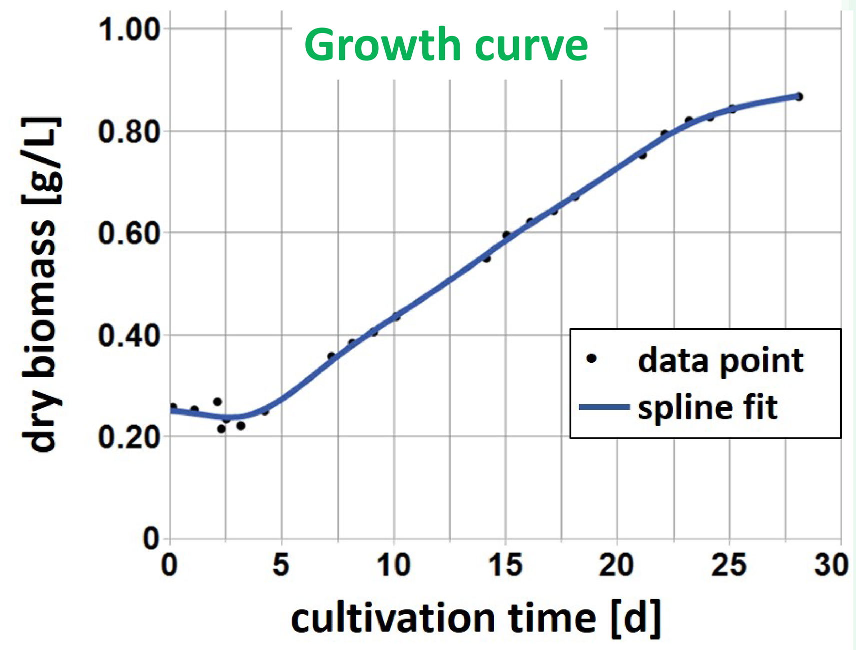
Introduction:

Photobioreactor designs for cultivation of phototrophic microorganisms have to cope with the challenge of limited light penetration of typically maximum 5 – 6 cm into the cultivation medium. Therefore, typical designs of photobioreactors are either one-dimensional (tubes), two-dimensional (plates, bags or ponds), or branched.[5, 6] Among tubes and plates, alternative new designs of photobioreactors focusing purely on artificial lighting that move beyond laboratory scale and achieve a lasting adoption in industry or by other research groups are rare.



Design of a Floating Light Ball Reactor and transformation of a brewery tank into a photobioreactor by adding assemblies of light balls. (a) One light ball submerged in a 22-L metal cylinder filled with water. (b) 300-L brewery tank used in this work. (c) CAD model of light ball assemblies realized in the brewery tank. (d) Top view after light ball installation. (e) Top view during cultivation of *Phaeodactylum tricornutum*.

Biofilm harvest:

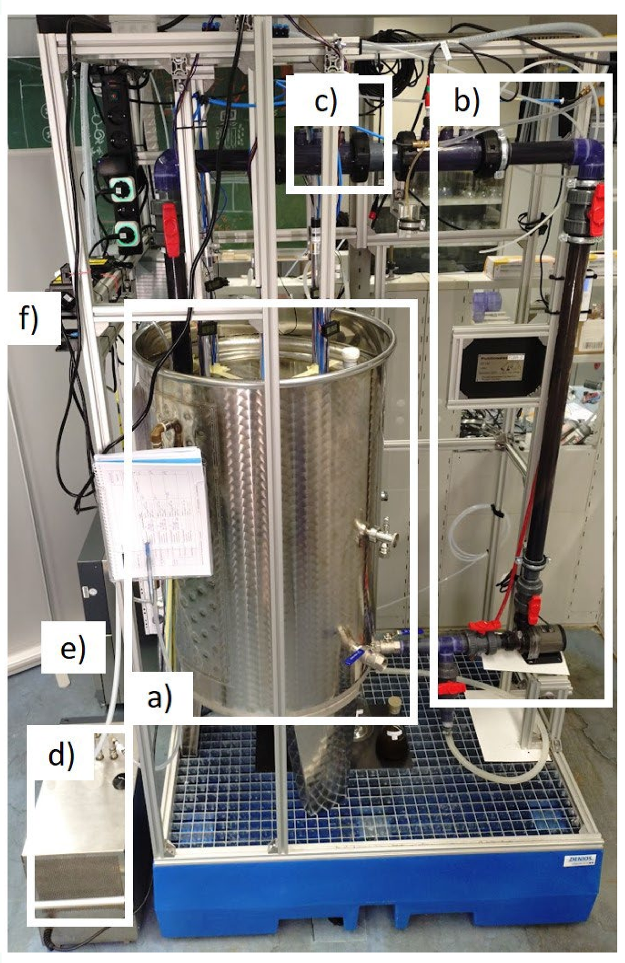


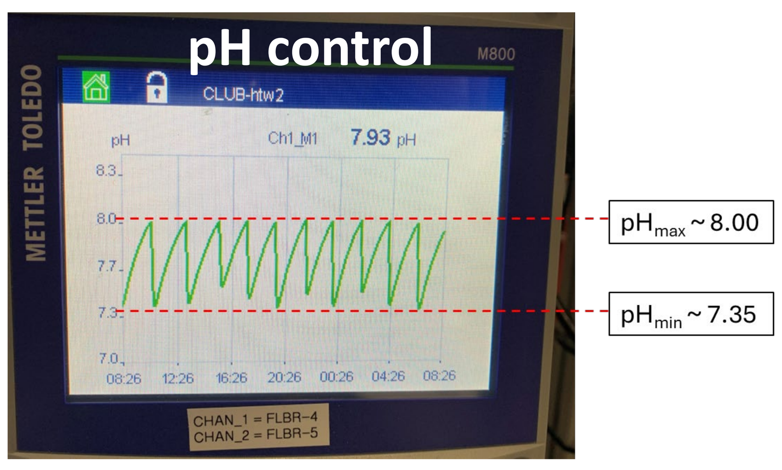
Objectives:

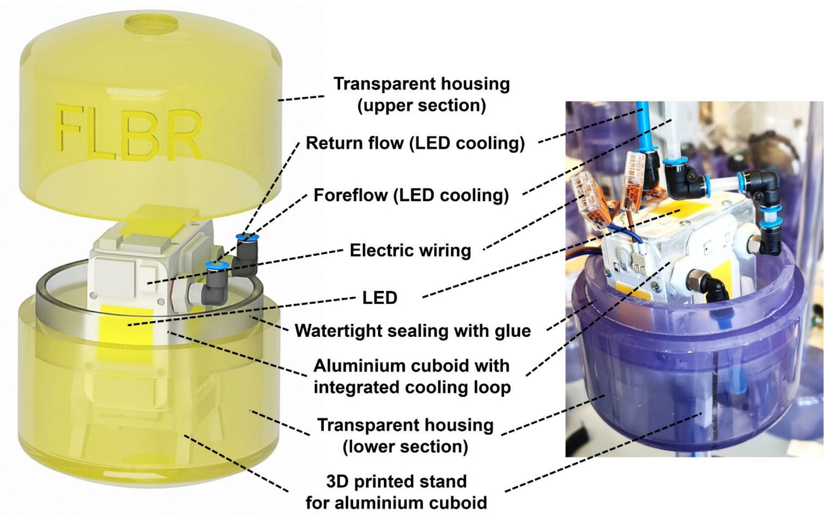
- Development of a new photobioreactor design with three-dimensional light entry
- Proof-of-case of the Floating Light Ball Reactor (FLBR®) for microalgae cultivation at different scales
- Demonstrate feasibility for scale-up

Experimental setup 234-L scale:

a) 300-L stainless steel brewery tank (500TFK300ZK, Zottel, 1.4301) with recirculation loop and bottom gas inlet **b)** PVC-U DN 50 recirculation loop with DC Runner 9.3 pump (65 W); effective flow rate: 7 m³/h **c)** pH probe INPRO 3253I/SG/120 (Mettler-Toledo), calibrated with Certipur® buffers (pH 4.01, 7.00, 10.00) **d)** Huber Unichiller Olé connected to the aluminium cuboids of the light ball assemblies for LED cooling **e)** Huber Unichiller connected to the tank jacket for reactor cooling **f)** Mettler-Toledo M800 PID controller and frequency dimmers for light ball control; electrical LED power consumption measured **Aeration/CO_2 supply:** 300 L/h air via sterile filter (Midisart 2000, Sartorius); pH-controlled CO_2 injection via solenoid valve.





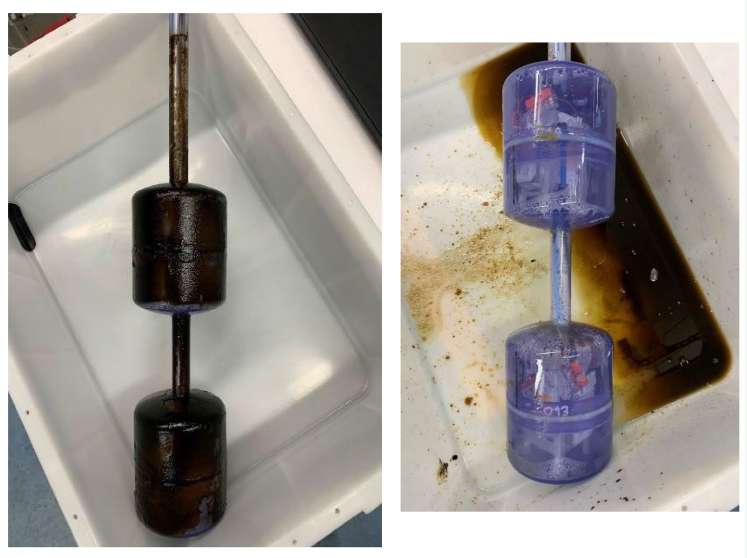


Construction of a Light Ball:

- Low-component light ball design
- Six dimmable high-power LEDs
- Up to 25 W neat lighting power per LED
- Waterproof transparent PVC housing with integrated housing
- Cooling circuit attached to the aluminium cuboid

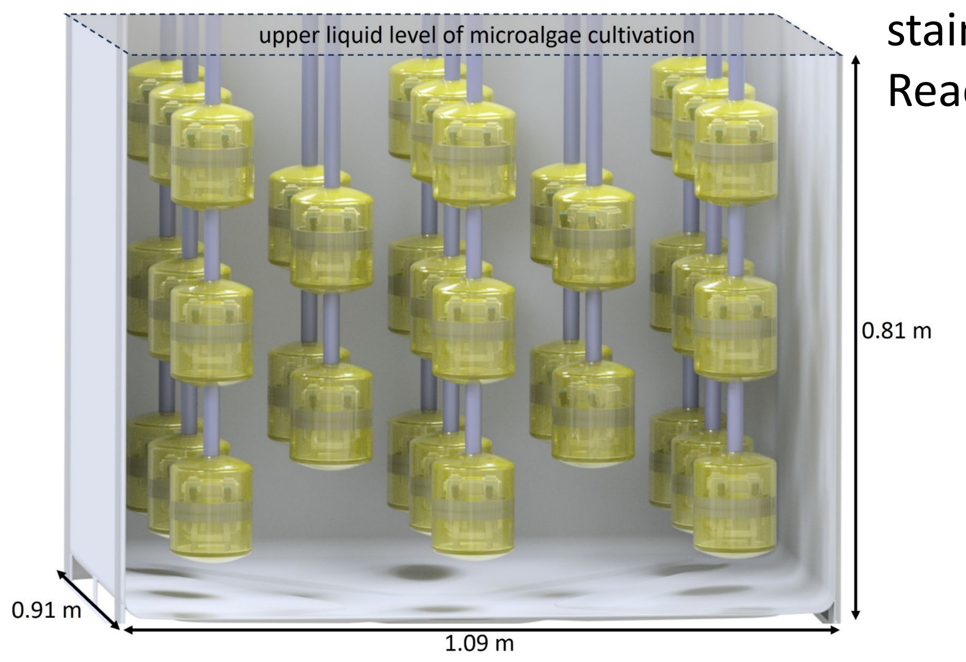
Biofilm Handling - Flexibility:

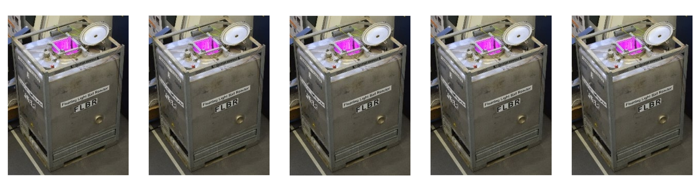
Potential biofilm formation can be flexibly handled by quickly cleaning or replacing the light ball assemblies, while at the same time harvesting the biofilm biomass. After four weeks, the light balls were cleaned outside and the biofilm and deposits onto the light balls were harvested. Simple rinsing off using a lab spray bottle and wiping with a plastic scraper was sufficient for cleaning and re-addition into FLBR® within four hours to continue cultivation.



Next step 757-L cultivation:

Design model for transformation of a 1000-L stainless-steel IBC into a 757-L Floating Light Ball Reactor using 35 light balls.





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Chemie Labor Umwelt Bioverfahrenstechnik by Prof. Timo Gehring™

References & Conflict of Interest: [1] T. Gehring, Y. S. L. Choo, J. Vidal and F. M. Fung, *Sustainability & Circularity NOW* **2026**, *03*. [2] The presented technology has been filed for patent application and comprises trade mark registrations: Gehring, T.; Maurer, P. "Assemblies, elements, methods, and systems for illumination", filed for patent application 25.07.2024, Application number EP24190886.2. Gehring, T.; Maurer, P. "Elements, systems, and methods for illumination", filed for patent application 17.06.2024, Application number EP24182686.6. "FLBR" has been registered as a word mark at EUIPO (019090215) [3] the logo is a figurative mark registrered at EUIPO (019142975). [4] Gehring, T.; Maurer, P.; Yildirim, M.; Lierse, M. S.; Ickes, R., *Sustainability & Circularity NOW* **2025**; 02: a27274980, DOI: 10.1055/a-2727-4980. [5] Heining, M.; Sutor, A.; Stute, S. C.; Lindenberger, C. P.; Buchholz, R. *Journal of Applied Phycology* **2015**, *27* (1), 59–66. DOI: 10.1007/s10811-014-0290-x. [6] Murray, A. M.; Fotidis, I. A.; Isenschmid, A.; Haxthausen, K. R. A.; Angelidaki, I. *Algal Research* **2017**, 25, 244–251. DOI:https://doi.org/10.1016/j.algal.2017.05.015. [7] The CLUB-Logo is a registered trade mark at DPMA (302023230702). All photos by Timo Gehring and Mutlu Yildirim

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