DOTS

sbi SCIENTIFIC BIOPROCESSING

CGQ / BioR Customized

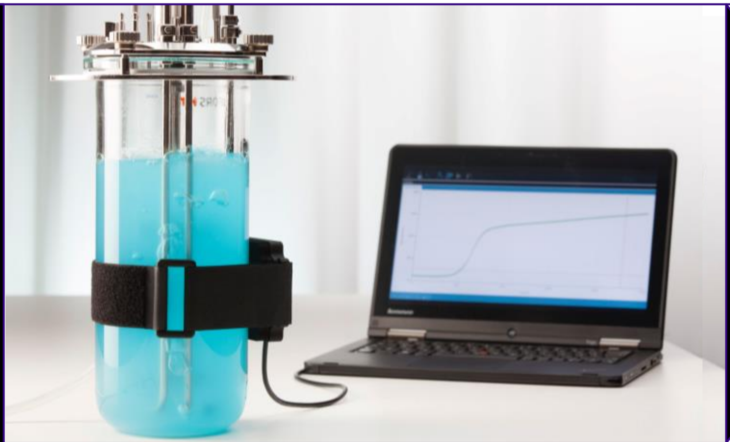
ONLINE BIOMASS MONITORING FOR PHOTOTROPHIC APPLICATIONS

The CGQ and CGQ BioR allow for non-invasive online biomass monitoring in shake flasks and bioreactors.

Cell Growth Quantifier (CGQ) and CGQ BioR

CGQ - Shake Flasks

CGQ BioR - Bioreactors



A CGQ system consists of three components: the sensor(s), the hub, and the DOTS Software.

Hardware & Software Components

CGQ Sensor/ CGQ BioR sensor

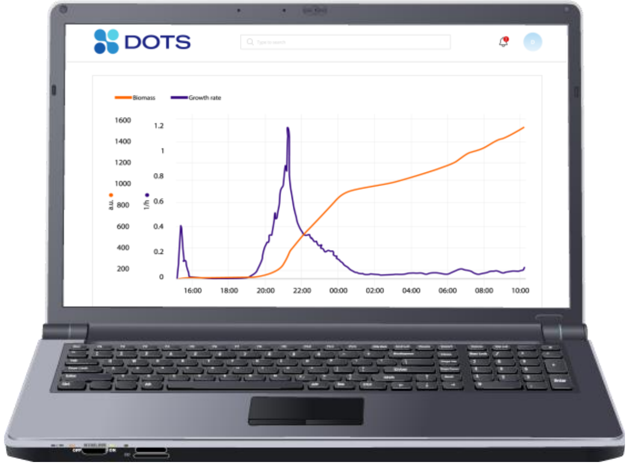
The CGQ sensor plates are positioned under the shake flask, the BioR sensors are attached to the wall of the bioreactor. Both are designed to measure the biomass continuously and non-invasively.

Hub

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

The hub bundles the data from all monitored flasks or reactors and sends it to the DOTS Software.

DOTS Software

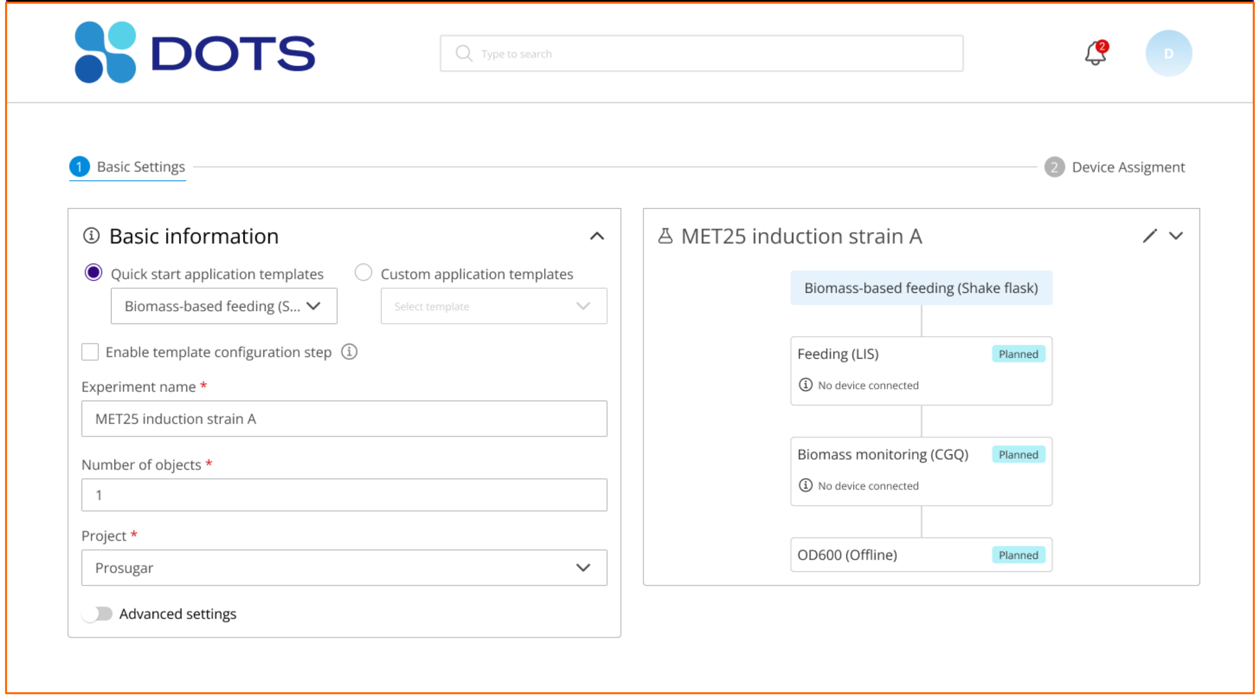

DOTS
Biomass
Growth rate
1600
1400
1200
1000
800
600
400
200
1.2
1
0.8
0.6
0.4
0.2
0
16:00
18:00
20:00
22:00
00:00
02:00
04:00
06:00
08:00
10:00

DOTS Software enables a simplified control of sensors and visualizes the received data from all monitored vessels in real-time.

The DOTS Software enables easy sensor handling and experiment set up.

Exemplary Screenshots

Create an experiment with pre-defined application templates


DOTS
Type to search
D
1 Basic Settings
2 Device Assigment
Basic information

● Quick start application templates ○ Custom application templates

Biomass-based feeding (S...

Select template

☐ Enable template configuration step

Experiment name *
MET25 induction strain A

Number of objects *
1

Project *
Prosugar

Advanced settings

MET25 induction strain A

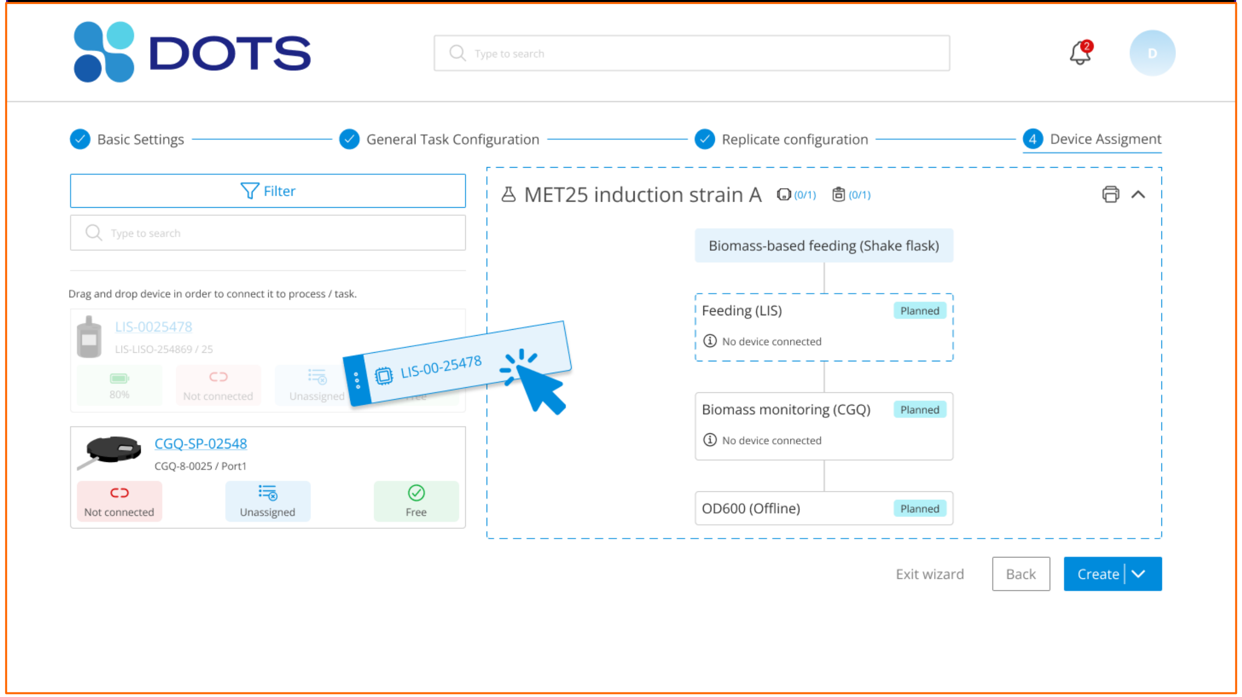
Biomass-based feeding (Shake flask)

Feeding (LIS) Planned
No device connected

Biomass monitoring (CGQ) Planned
No device connected

OD600 (Offline) Planned

Assign sensors to planned experiments via drag and drop


DOTS
Type to search
D
Basic Settings
General Task Configuration
Replicate configuration
4 Device Assigment
Filter
Type to search
LIS-0025478
LIS-LISO-254869 / 25
80%
Not connected
Unassigned
LIS-00-25478
CGQ-SP-02548
CGQ-8-0025 / Port1
Not connected
Unassigned
Free
Exit wizard
Back
Create

Drag and drop device in order to connect it to process / task.

MET25 induction strain A (0/1) (0/1)

Biomass-based feeding (Shake flask)

Feeding (LIS) Planned
No device connected

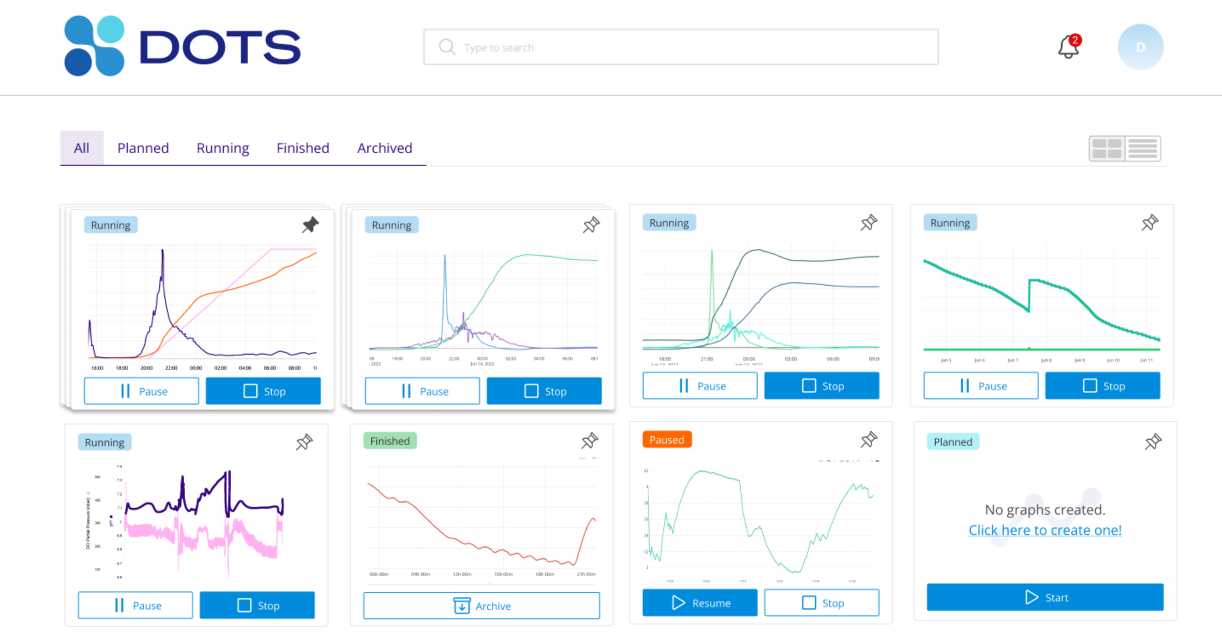
Biomass monitoring (CGQ) Planned
No device connected

OD600 (Offline) Planned

The DOTS Software provides a comprehensive overview of your experiments and visualizes your data in real-time.

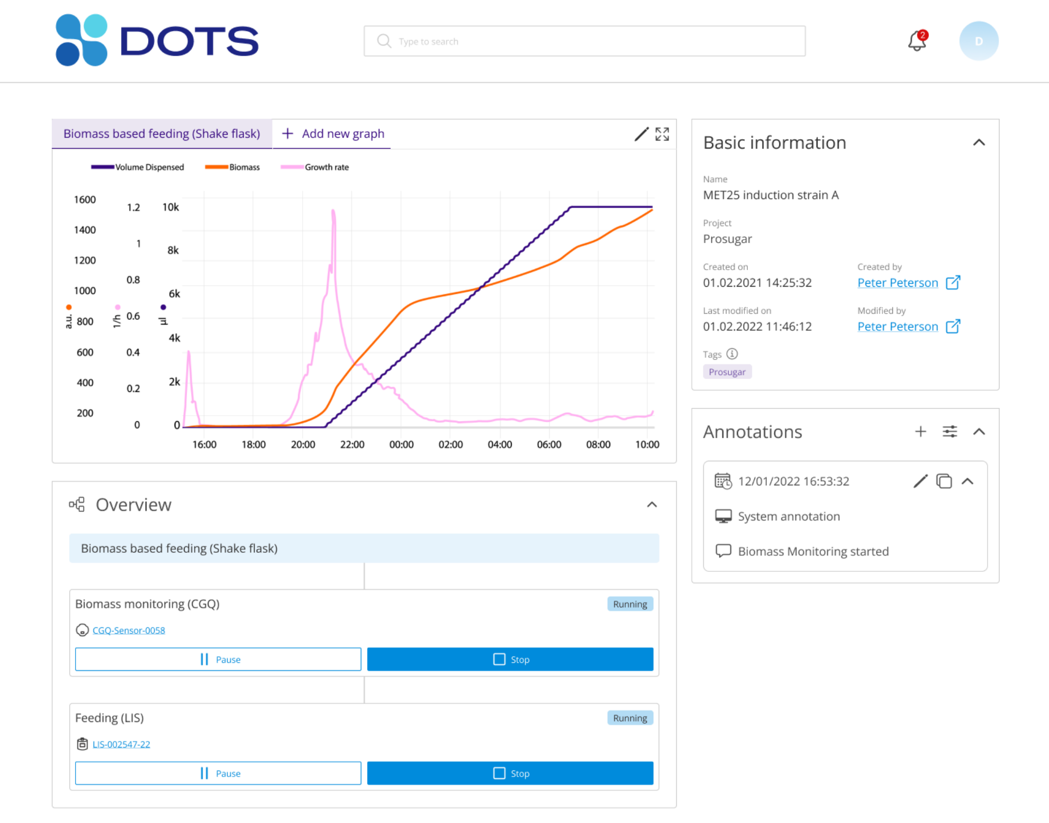
DOTS Software Modules for Data Visualization

The dashboard schema provides an overview over all running, planned, or finished experiments


DOTS
Type to search
D
All
Planned
Running
Finished
Archived
Running
Pause
Stop
Finished
Archive
Paused
Resume
Planned
Start

No graphs created.
Click here to create one!

Data visualization tools enable a customized display of data in real-time


DOTS
Type to search
D
Biomass based feeding (Shake flask)
Add new graph
Volume Dispensed
Biomass
Growth rate
1600
1400
1200
1000
800
600
400
200
a.u.
1.2
1
0.8
0.6
0.4
0.2
0
1/h
10k
8k
6k
4k
2k
0
µl
16:00
18:00
20:00
22:00
00:00
02:00
04:00
06:00
08:00
10:00
Overview
Pause
Stop

Biomass based feeding (Shake flask)

Biomass monitoring (CGQ) Running

CGQ-Sensor-0058

Feeding (LIS) Running

LIS-002547-22

Basic information

Name
MET25 induction strain A

Project
Prosugar

Created on
01.02.2021 14:25:32

Created by
Peter Peterson

Last modified on
01.02.2022 11:46:12

Modified by
Peter Peterson

Tags
Prosugar

Annotations

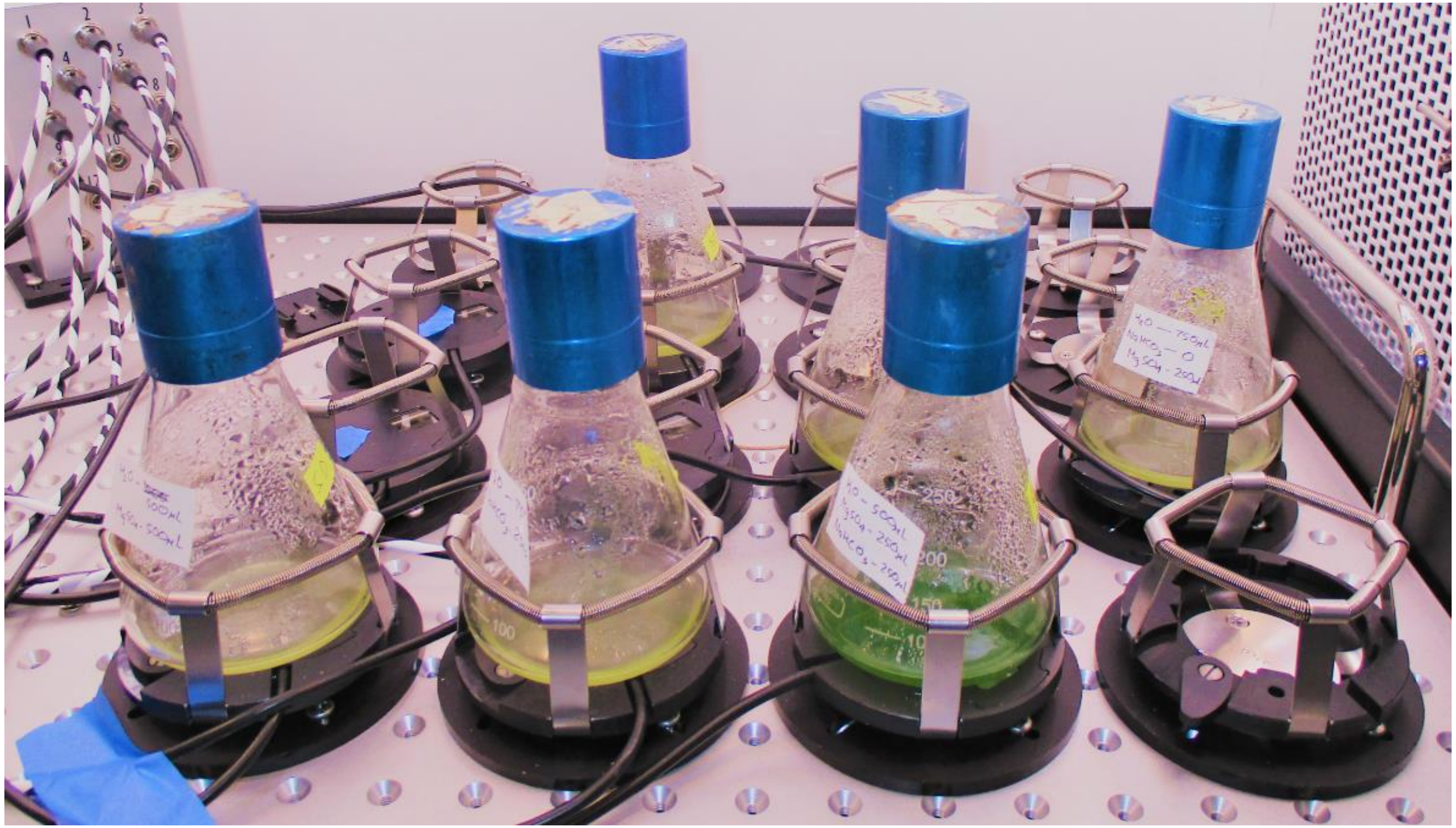
12/01/2022 16:53:32

System annotation

Biomass Monitoring started

The CGQ can be installed in any phototrophic shaker and be used with any available flask size.

Exemplary Picture of CGQ Sensors Mounted in a Phototrophic Shaker



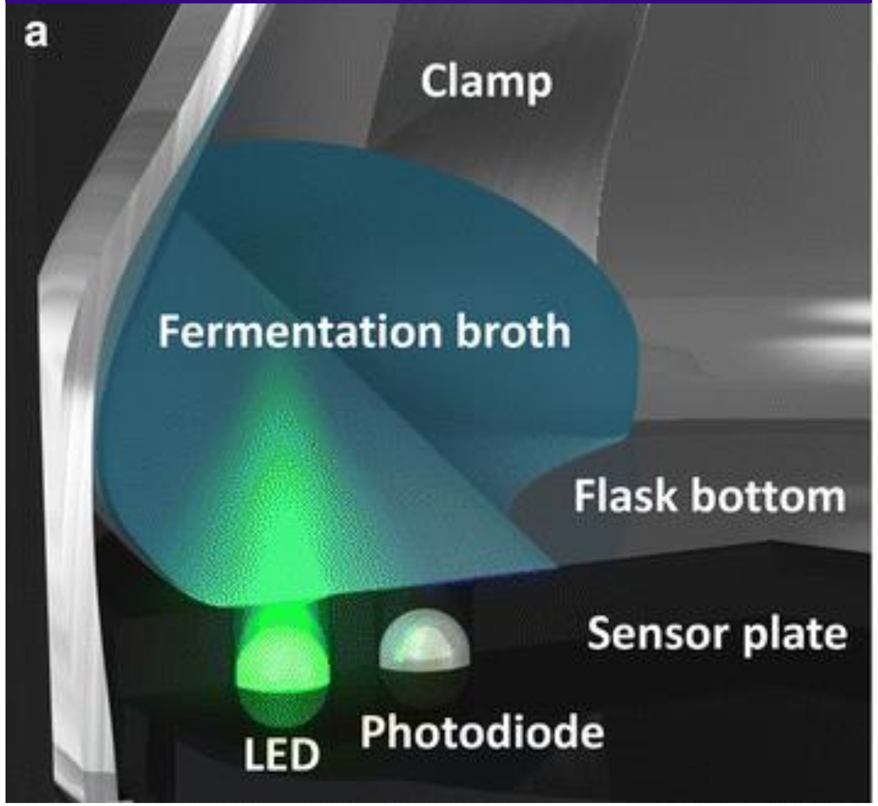
The CGQ BioR is perfectly suitable for specialized phototrophic bioreactors (photobioreactors) such as tubes or bags.

Exemplary Pictures of CGQ BioR Sensors Mounted to Different Types of Phototrophic Reactors

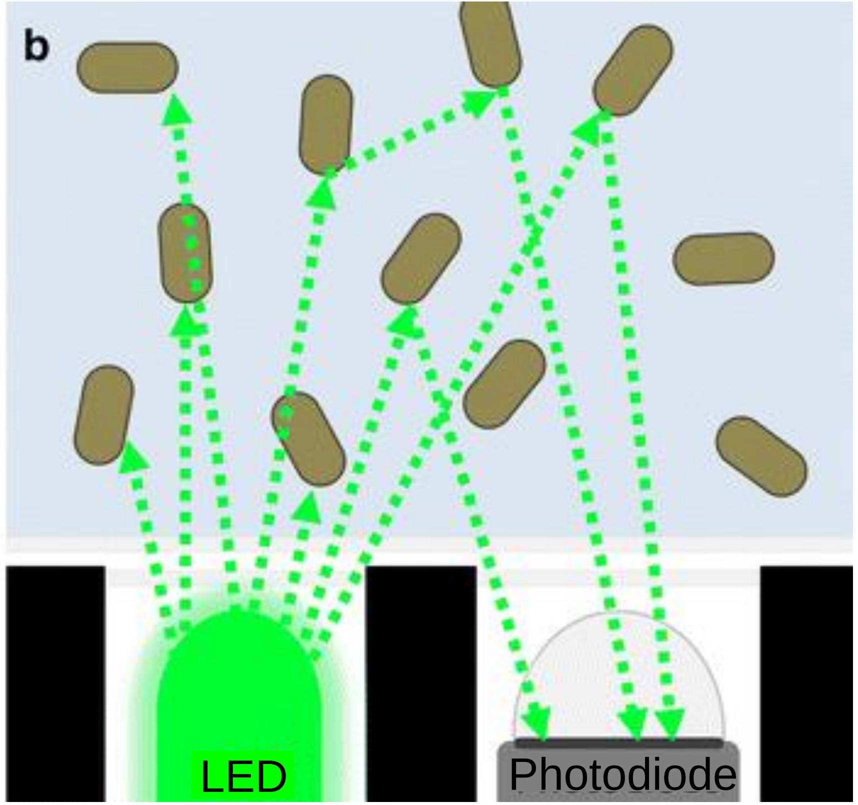
CGQ and CGQ BioR use backscattered light measurements allowing for accurate biomass monitoring in shaken cultures and bioreactors.

Measurement Principle

CGQ Sensing Architecture

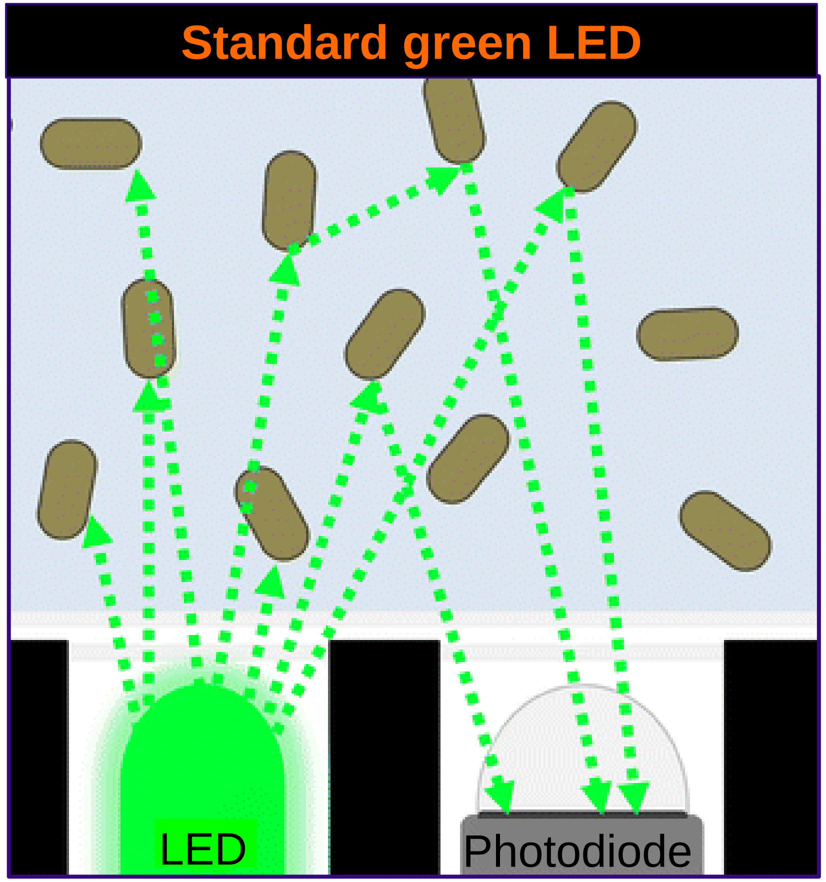

a
Clamp
Fermentation broth
Flask bottom
Sensor plate
LED
Photodiode

Biomass Monitoring via Backscattered Light Detection

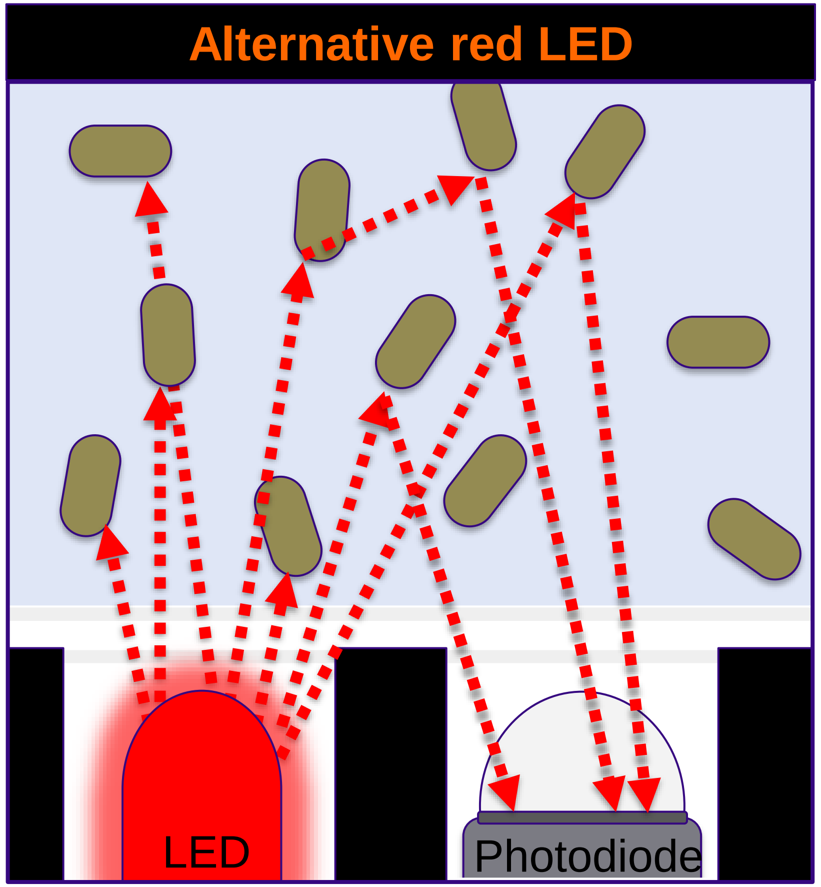

b
LED
Photodiode

Using different LEDs (green: 521 nm and red: 730 nm), the best wavelength for your phototrophic application can be chosen.

Sensors with Green and Red LEDs


Standard green LED
LED
Photodiode

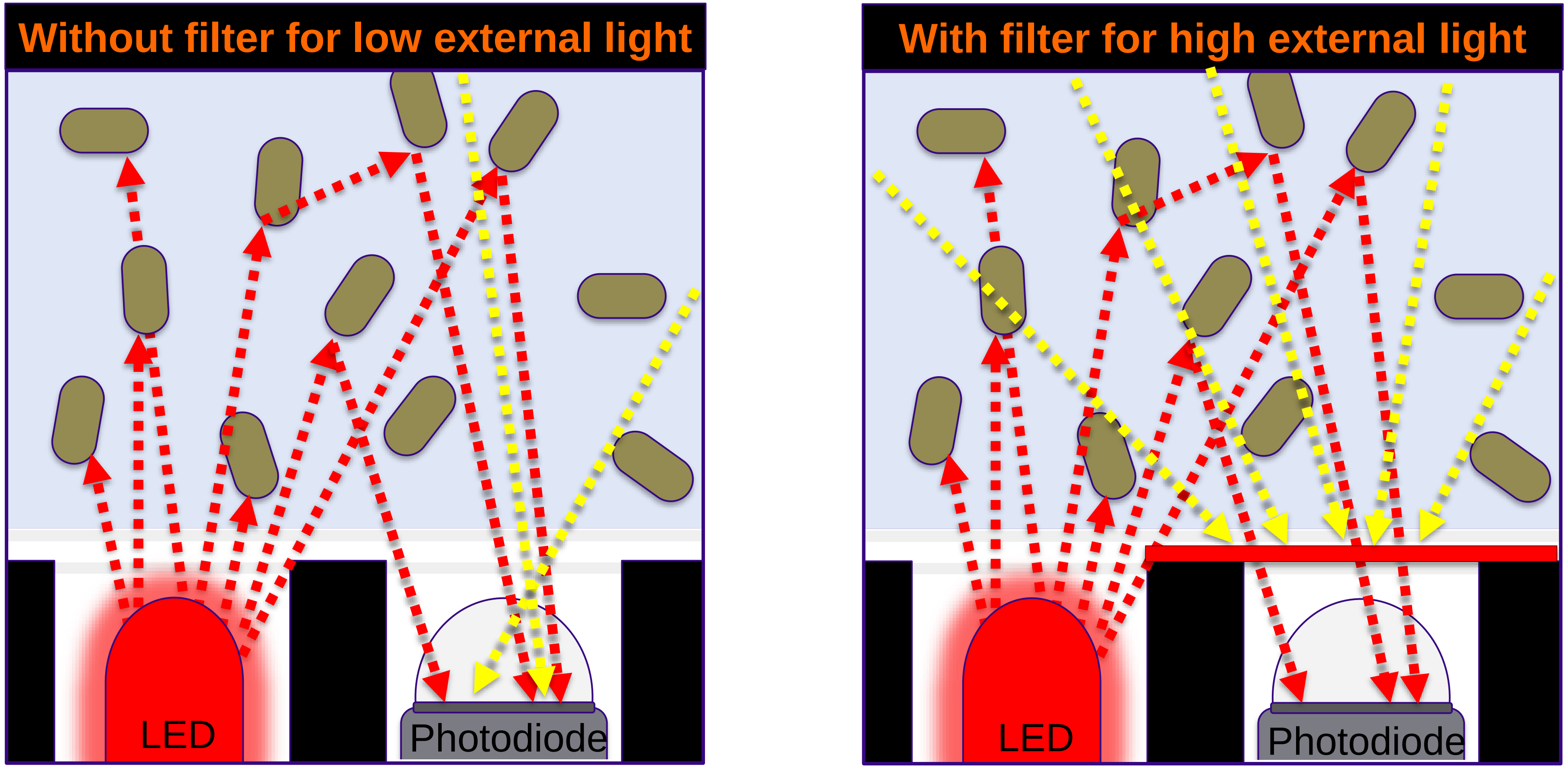
Green LED, 521 nm


Alternative red LED
LED
Photodiode

Red LED, 730 nm

For every wavelength, an additional filter can be applied to prevent signal interferences due to too much external light.

Sensors with Red LEDs with and without Filter



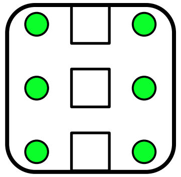
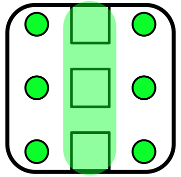
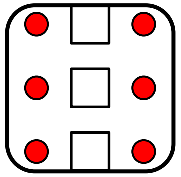
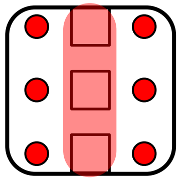
Without filter for low external light
LED
Photodiode
With filter for high external light
LED
Photodiode

Red LED, 730 nm, no filter

Red LED, 730 nm, additional filter

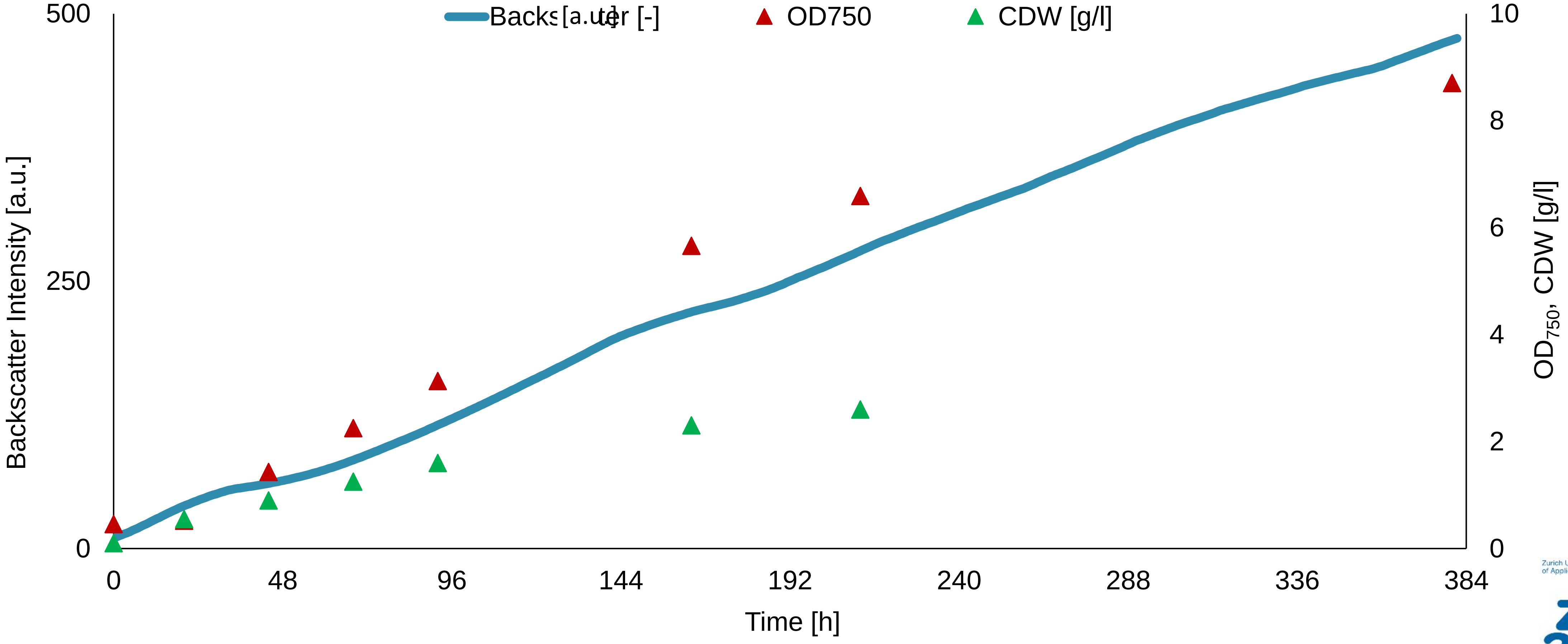
For both CGQ systems, four different sensors exist for phototrophic trials and can be tested simultaneously.

Different Sensors and Their Specifications

LED type	Hardware filter	Schematic	CGQ sensor number	CGQ BioR sensor number
Green LED 521 nm	No Filter		CGQ-SP-F-00198	CGQ-SP-BC-0004
Green LED 521 nm	Filter		CGQ-SP-F-00186	CGQ-SP-BC-0005
Red LED 730 nm	No Filter		CGQ-SP-F-00028	CGQ-SP-BC-0004
Red LED 730 nm	Filter		CGQ-SP-F-00029	CGQ-SP-BC-0006

The CGQ can be used for online monitoring of *Chlorella vulgaris* shake flask cultures and shows good correlation with offline data.

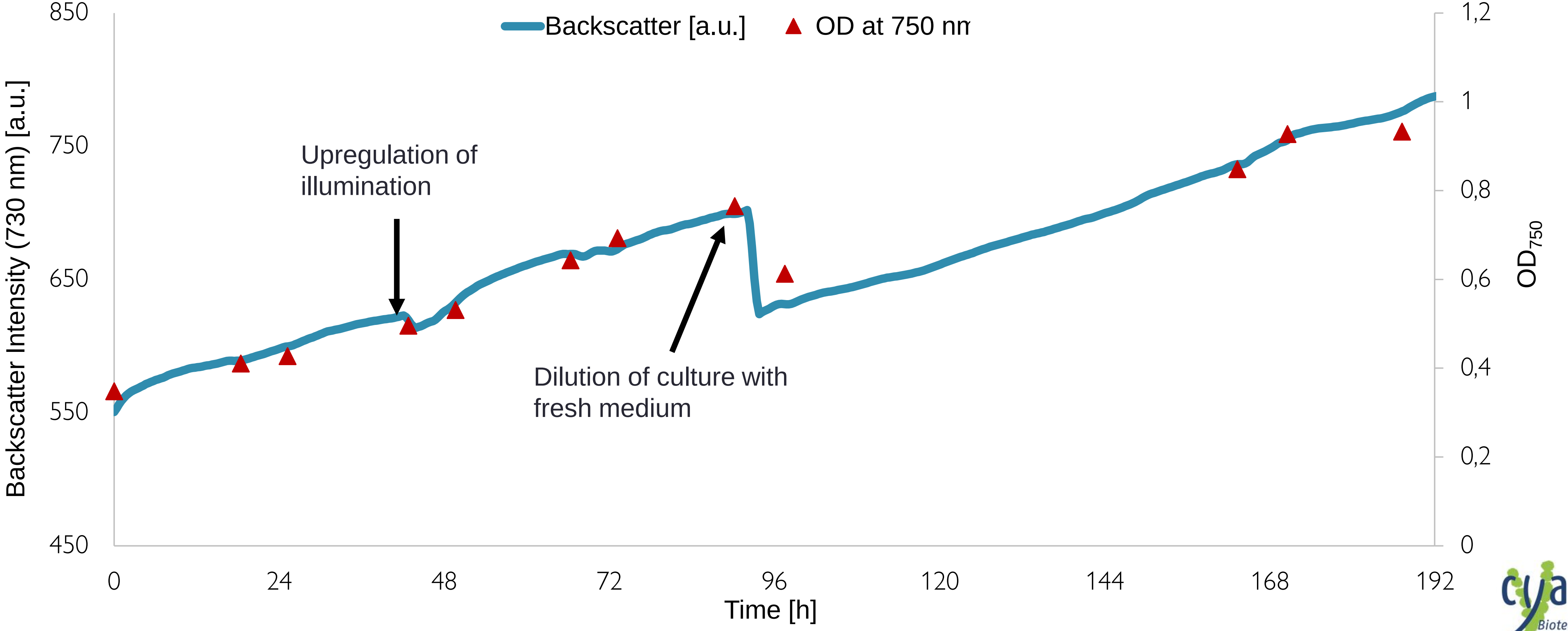
CGQ (850 nm, no filter), OD (750 nm) & Cell Dry Weight (CDW) Measurements: *Chlorella vulgaris*



Chlorella vulgaris, 50 mL BBM Medium, 250 mL Shake Flask, 28 °C, 130 rpm

The CGQ BioR is capable of monitoring *Microcystis aeruginosa* in balloon bioreactors and the data correlates nicely with optical density (OD)..

CGQ (730 nm) & OD (750 nm) Measurements: *Microcystis aeruginosa* CBT 480



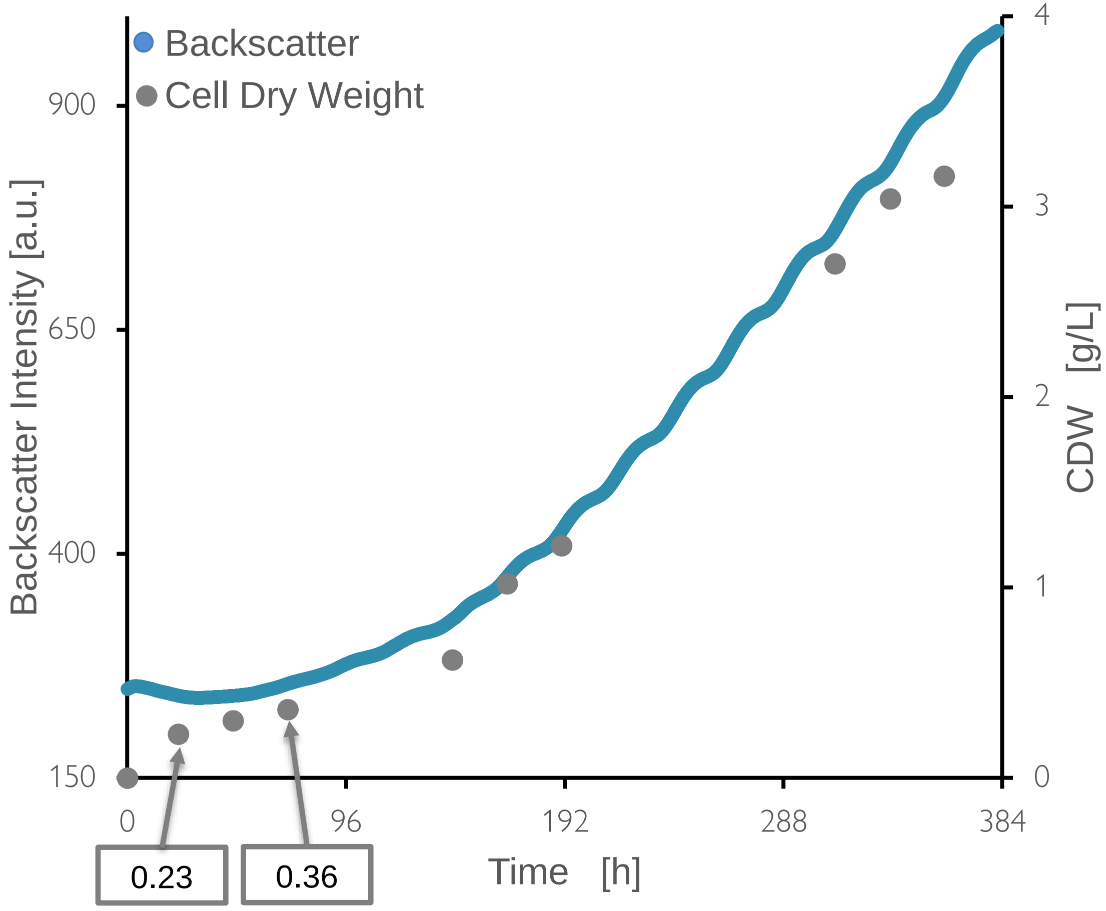
Upregulation of illumination

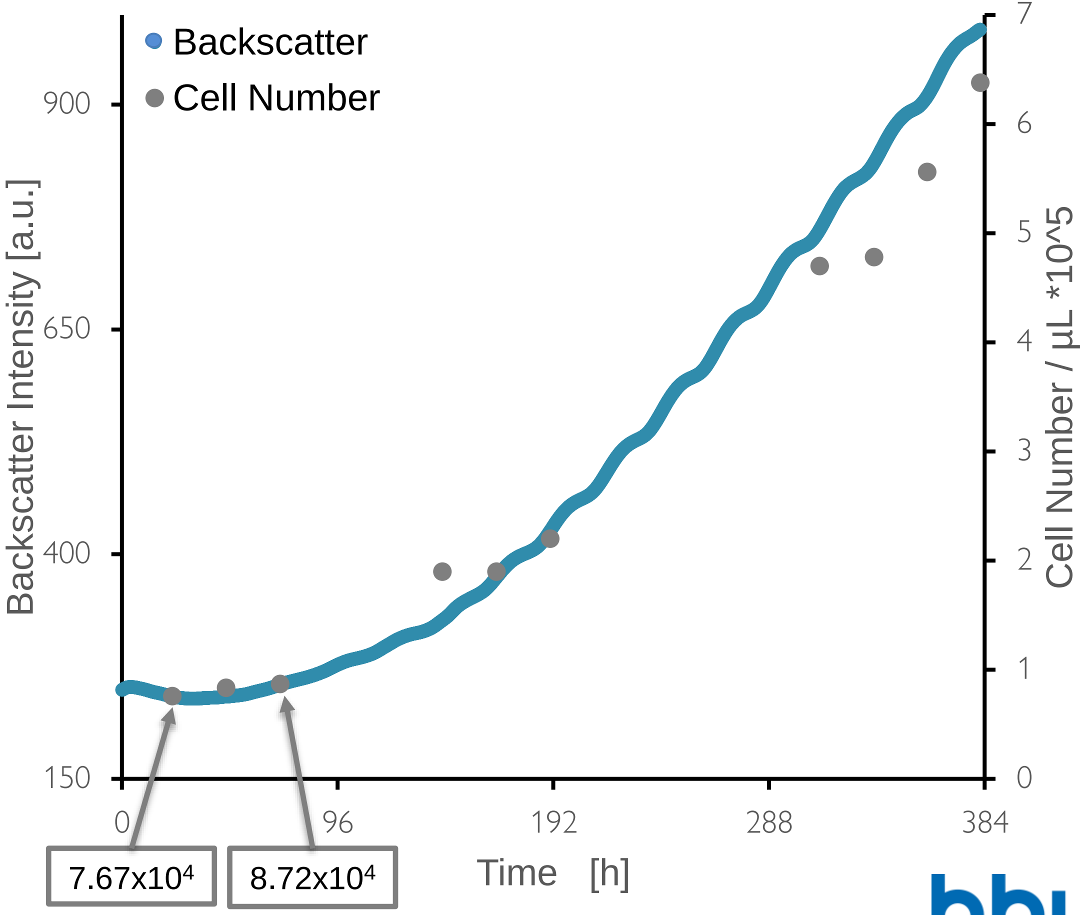
Dilution of culture with fresh medium

Microcystis aeruginosa CBT 480, 20 L BG11 Medium, 20 L balloon bioreactor, 28 °C

When monitoring *Synechococcus elongates*, the CGQ data correlates nicely with cell dry weight (CDW) and cell number.

CGQ (730 nm+filter), Cell Dry Weight (CDW) & Cell Number Measurements: *S. elongatus*



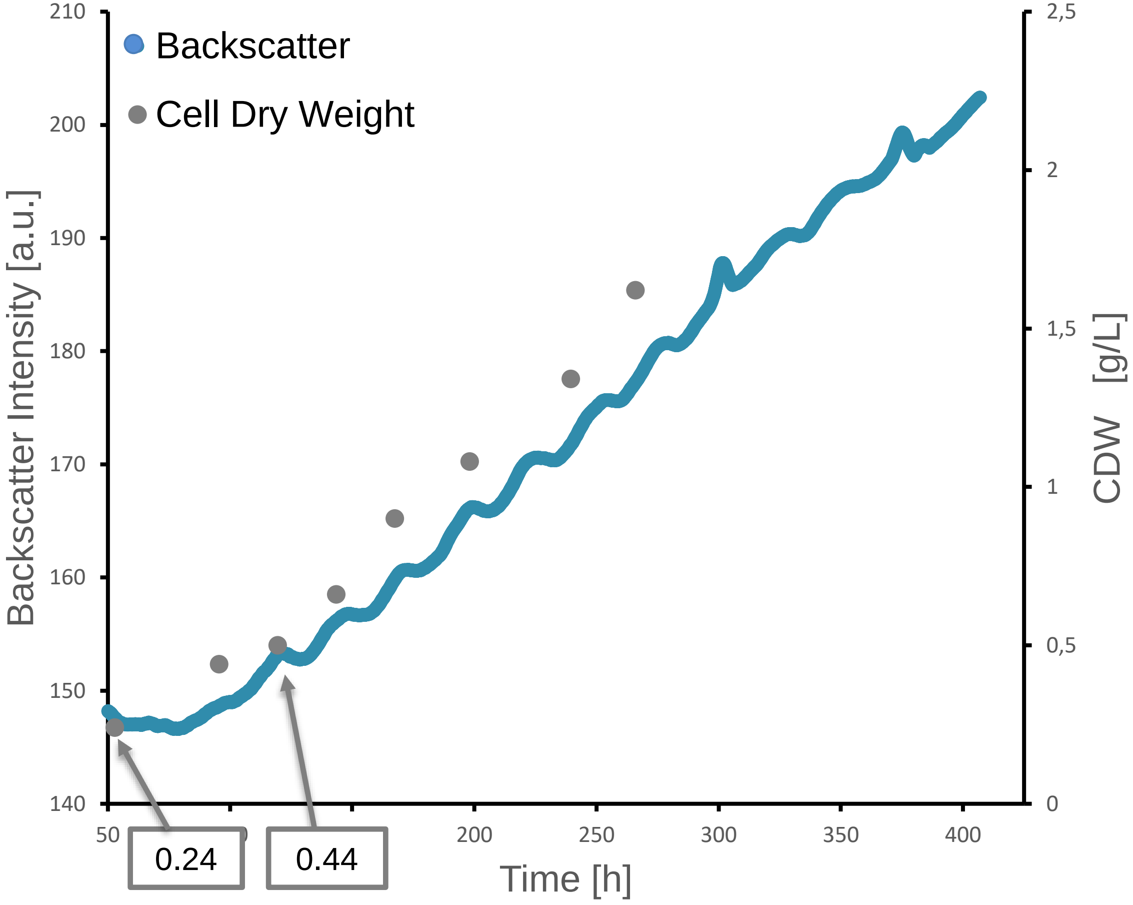


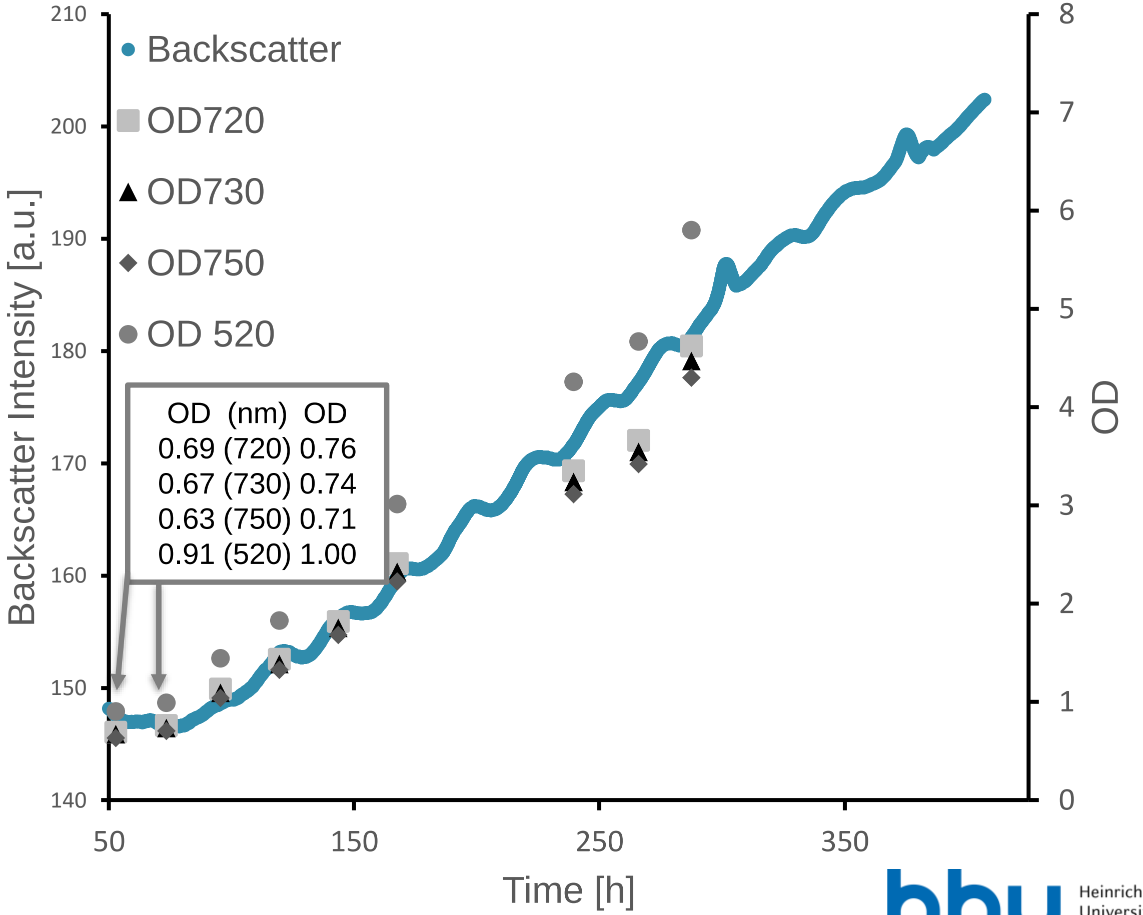
Synechococcus elongates, Medium: BG11, 100 mL in 250 mL flask, 80 µEinstein constant illumination, 150 rpm, 30°C

hhu Heinrich Heine Universität Düsseldorf

The CGQ can monitor *Synechocystes sp.* and the data correlates nicely with cell dry weight (CDW) and optical density (OD) at different wavelengths.

CGQ (521 nm, with filter), CDW & OD Measurements: *Synechocystis sp.*



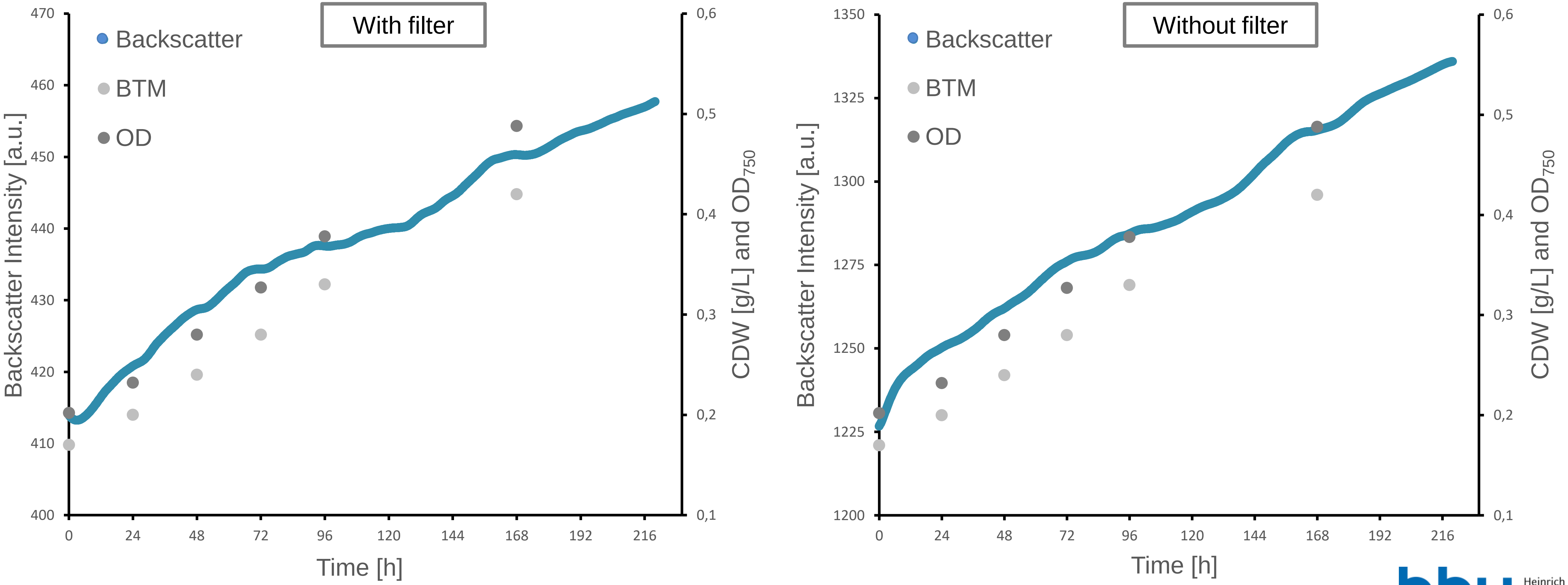


OD	(nm)	OD
0.69	(720)	0.76
0.67	(730)	0.74
0.63	(750)	0.71
0.91	(520)	1.00

Synechocystes sp., Medium: BG11, 100 mL in 250 mL flask, 80 µEinstein constant illumination, 150 rpm, 30°C

When monitoring *Arthrospira platensis*, the CGQ data correlates nicely with cell dry weight (CDW) and optical density (OD).

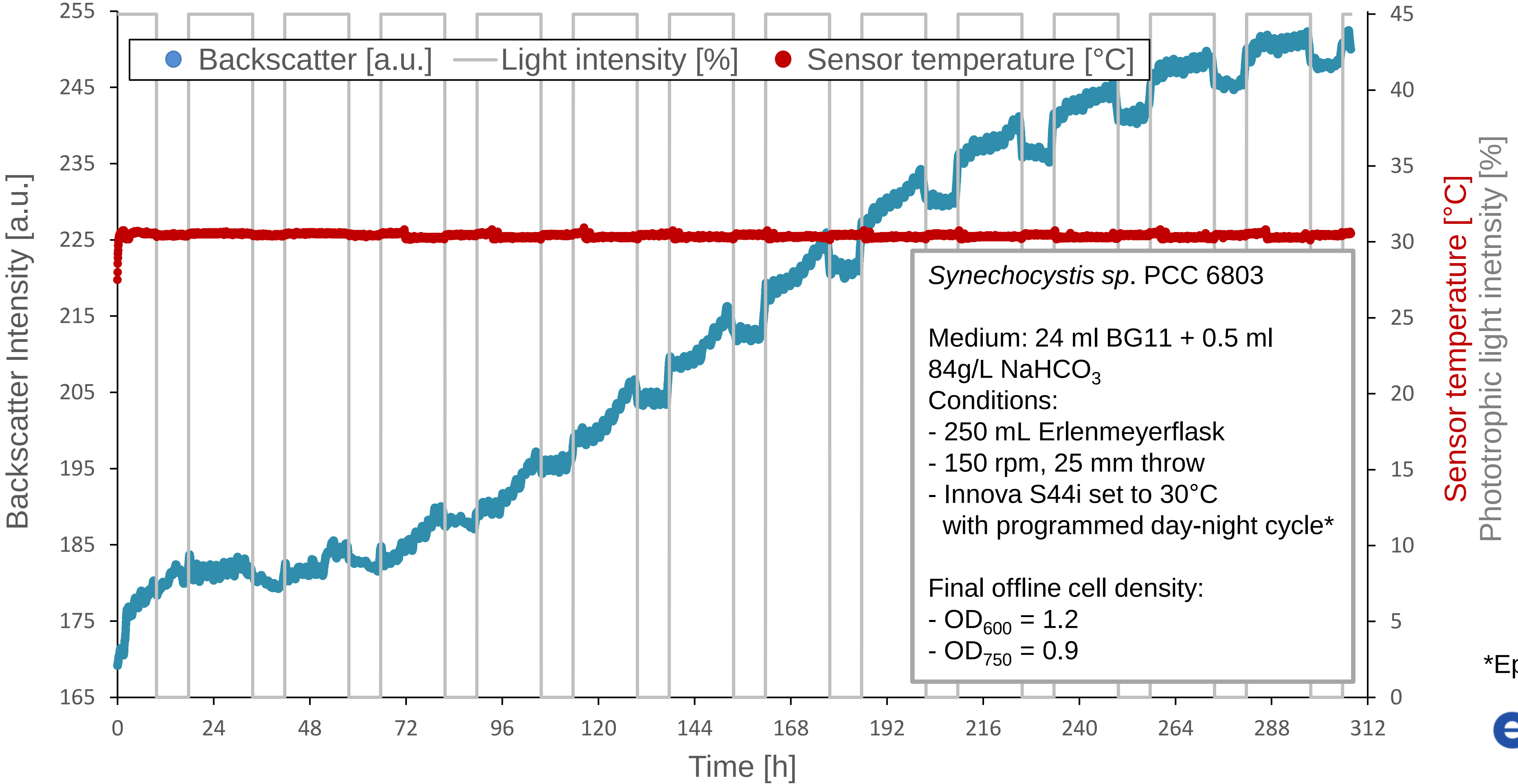
CGQ (521 nm, with/without filter), CDW & OD Measurements: *Arthrospira platensis*



Arthrospira platensis, 100 L Photobioreactor, 150 µmol photons m^{-2} s^{-1} constant illumination, 2 L/min gassing rate, 26°C

The phototrophic system can be used in a shaker with simulated day-night cycle*.

CGQ Measurements: *Synechocystis sp*. PCC 6803



Synechocystis sp. PCC 6803

Medium: 24 ml BG11 + 0.5 ml 84g/L $NaHCO_3$

Conditions:
- 250 mL Erlenmeyerflask
- 150 rpm, 25 mm throw
- Innova S44i set to 30°C with programmed day-night cycle*

Final offline cell density:
- OD_{600} = 1.2
- OD_{750} = 0.9

*Eppendorf Application Note

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