



Cell Growth Quantifier (CGQ)

ONLINE BIOMASS MONITORING FOR SHAKE FLASKS

The CGQ is a sensor-based technology for non-invasive, online biomass monitoring in shake flasks.

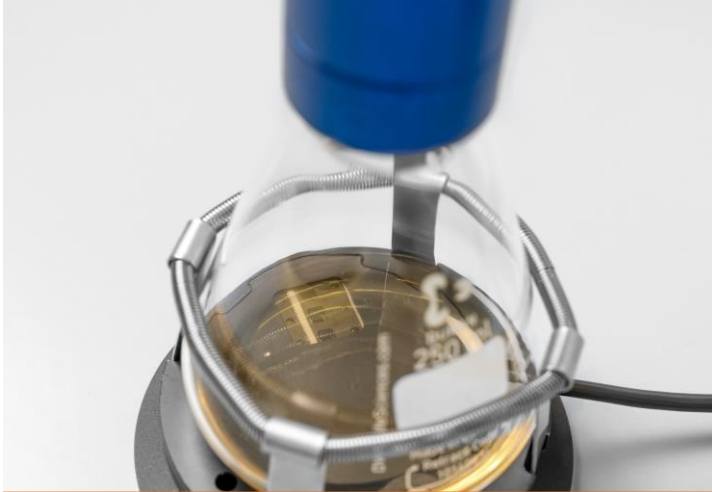
Cell Growth Quantifier (CGQ)



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

Hardware & Software Components

CGQ Sensor



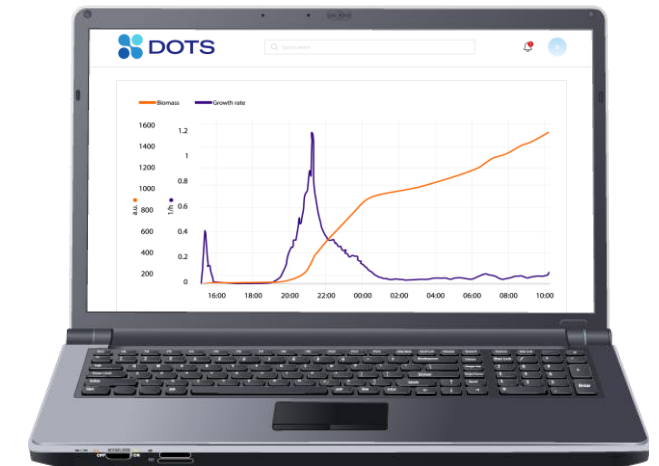
The sensors are positioned under the shake flasks and measure the biomass non-invasively.

CGQ Hub



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

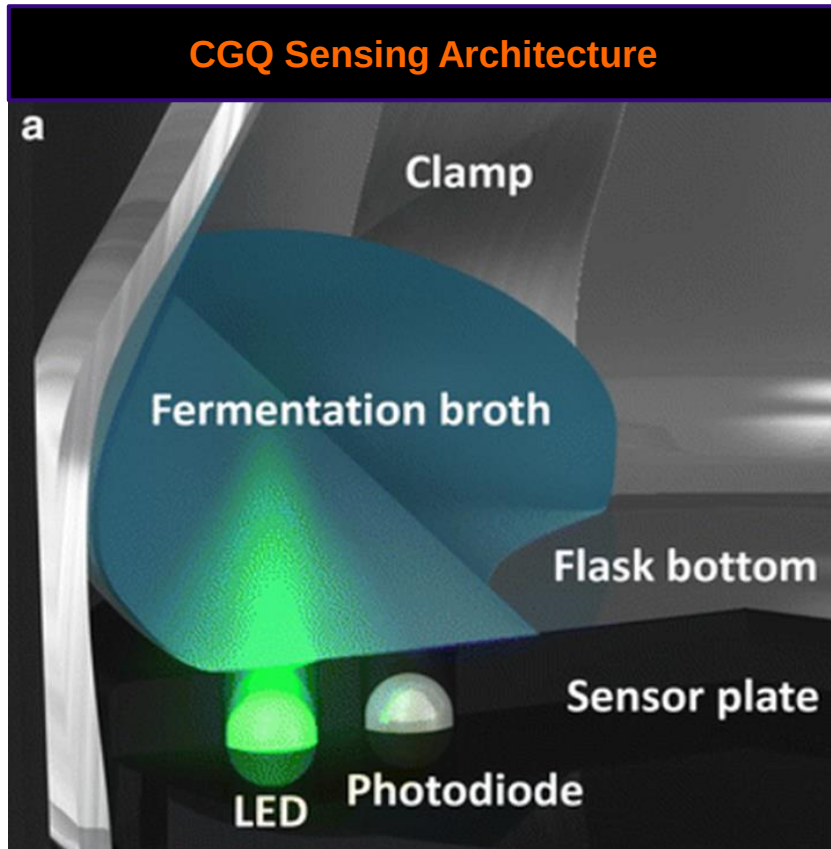
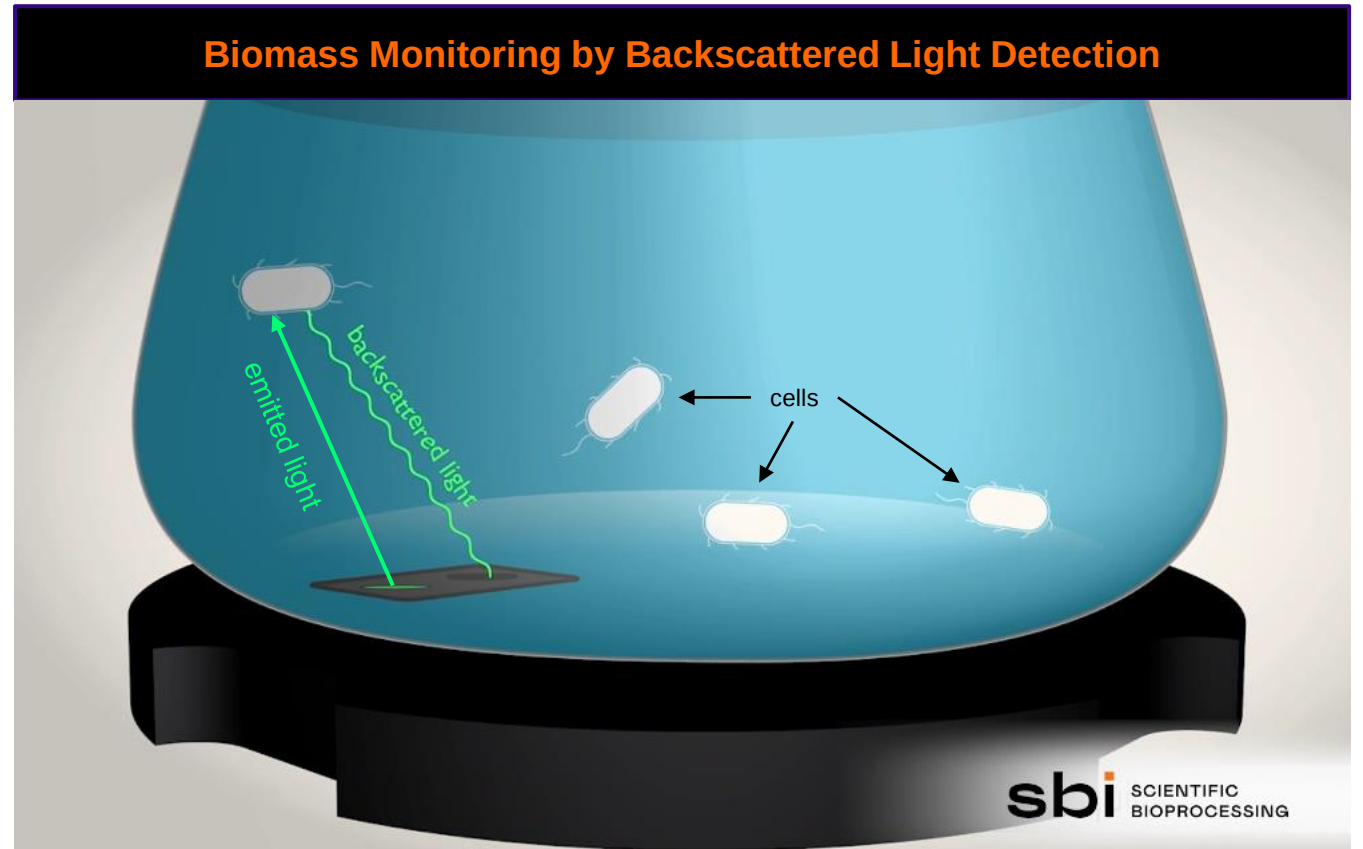
DOTS Software



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

The CGQ implements backscattered light measurement, allowing for optical, non-invasive biomass monitoring in shaken cultures.

Measurement Principle



Use the same sensor for various shake flask sizes with the CGQ – Sensor Adapters.

One Sensor for All Common Shake Flask Sizes

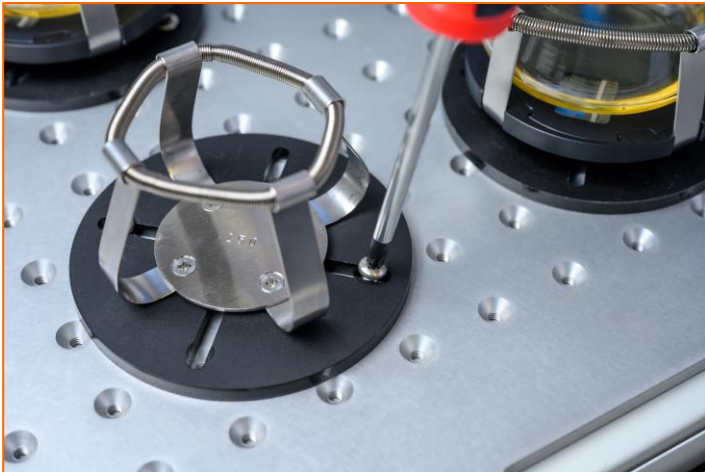


Advantages

- **Maximum flexibility:** The same sensor plate can be used for different shake flask sizes
- **Cost savings:** If you start using other flask sizes down the road, you only need to invest in adapters and not buy additional sensor plates

CGQ – Sticky Mat / non-INFORS Shakers Adapters and CGQ – Bottle Adapters allow maximum flexibility when choosing a shaker or flask type.

Adapters for Shakers and Flasks



**CGQ – Sticky Mat / non-INFORS
Shakers Adapter on shaker**



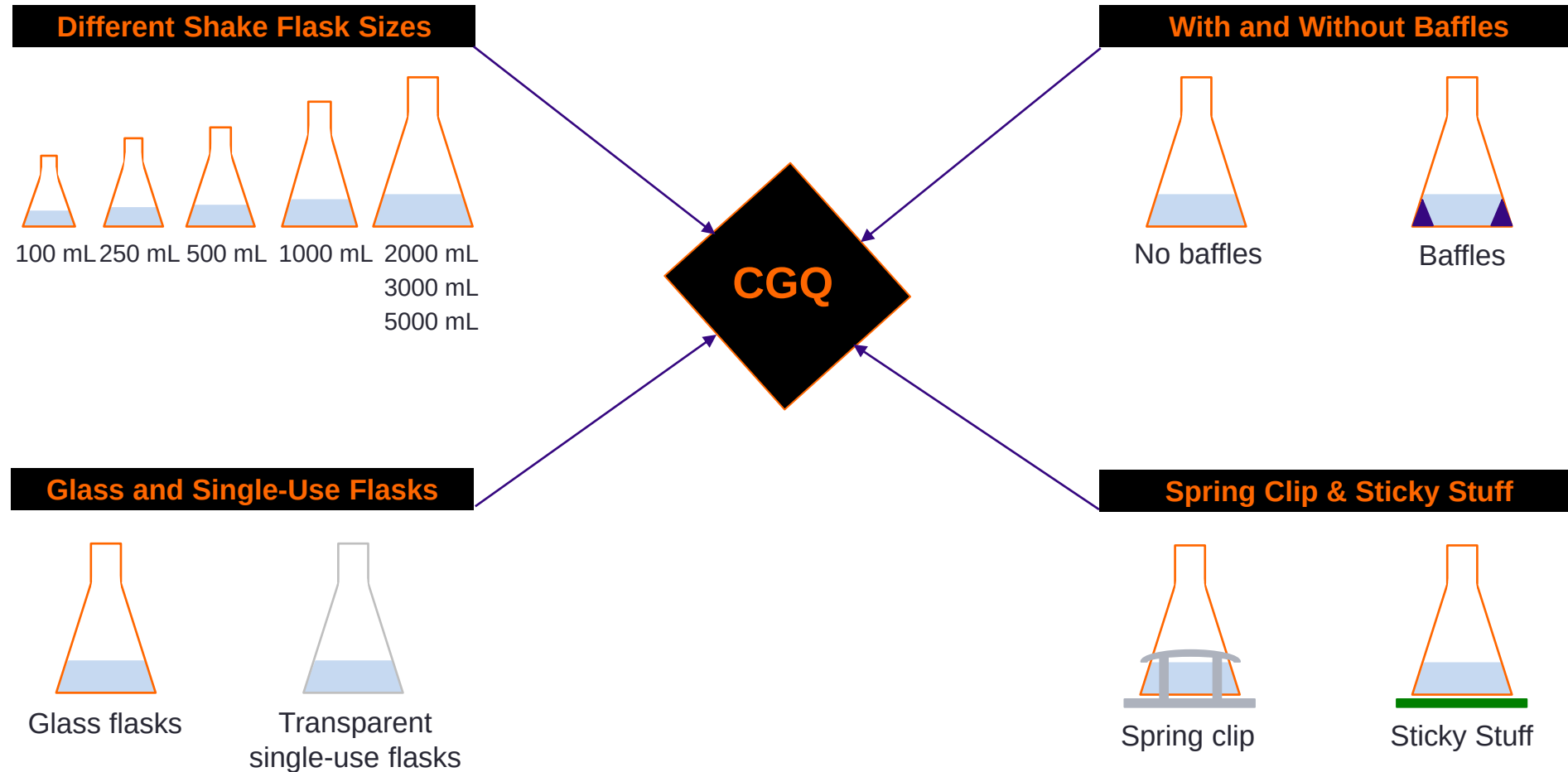
**CGQ – Sticky Mat / non-INFORS
Shakers Adapter on Sticky Mat**



**Bottle – Adapter for serum bottles or
Schott flasks**

The CGQ is compatible with all common sizes and kinds of shake flasks (and other vessels) and every common type of shaker.

Compatible Laboratory Infrastructure



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

Exemplary Screenshots

Create an experiment with pre-defined application templates

The screenshot shows the DOTS software interface with the 'Basic Settings' step selected. The 'Basic information' section includes options for 'Quick start application templates' and 'Custom application templates', a dropdown for 'Biomass-based feeding (S...)', a checkbox for 'Enable template configuration step', and fields for 'Experiment name *' (MET25 induction strain A), 'Number of objects *' (1), and 'Project *' (Prosugar). An 'Advanced settings' toggle is at the bottom. The 'Device Assignment' step shows a diagram for 'MET25 induction strain A' with tasks: 'Biomass-based feeding (Shake flask)', 'Feeding (LIS)' (Planned), 'Biomass monitoring (CGQ)' (Planned), and 'OD600 (Offline)' (Planned). Each task has a status indicator 'No device connected'.

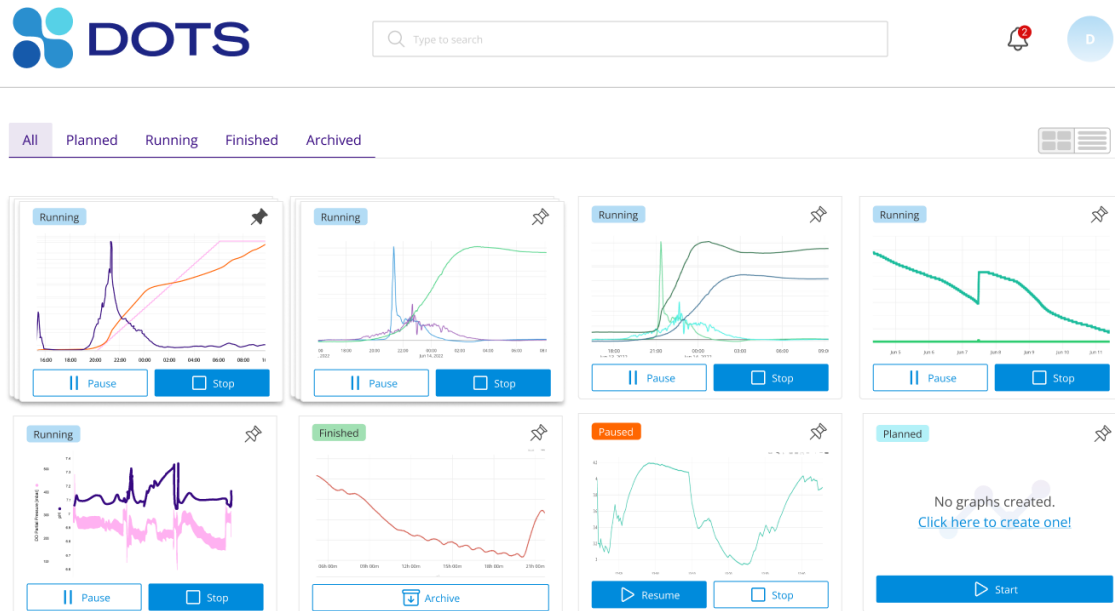
Assign sensors to planned experiments via drag and drop

The screenshot shows the DOTS software interface with the 'Device Assignment' step selected. The 'General Task Configuration' step is also visible. The 'Device Assignment' section shows a diagram for 'MET25 induction strain A' with tasks: 'Biomass-based feeding (Shake flask)', 'Feeding (LIS)' (Planned), 'Biomass monitoring (CGQ)' (Planned), and 'OD600 (Offline)' (Planned). A dashed box highlights the 'Feeding (LIS)' task. Below the diagram, a list of devices is shown: 'LIS-0025478' (LIS-LISO-254869 / 25, 80% battery, Not connected), 'CGQ-SP-02548' (CGQ-8-0025 / Port1, Not connected), and 'LIS-00-25478' (Free). A blue arrow points to the 'LIS-00-25478' device, indicating it is being assigned to the 'Feeding (LIS)' task.

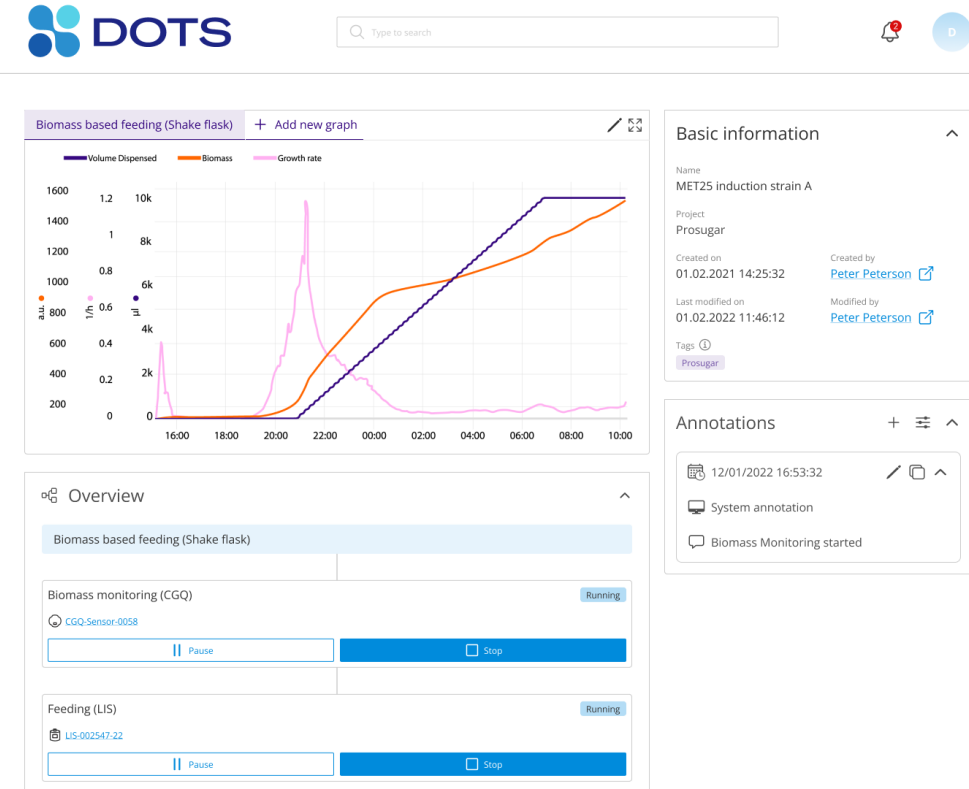
The DOTS Software provides a comprehensive overview of your experiments and visualizes your data in real-time.

DOTS Software Modules for Data Visualization

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



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



Various organisms like bacteria, archaea, filamentous fungi and yeast have been successfully monitored with the CGQ.

Example Organisms Successfully Monitored with the CGQ technology

Bacteria

- *Escherichia coli*
- *Corynebacterium glutamicum*
- *Bacillus subtilis*
- *Pseudomonas putida*
- *Pseudomonas taiwanensis*
- *Gluconobacter oxydans*
- *Lactobacillus plantarum*
- *Vibrio natriegens*
- *Vibrio cholerae*
- *Staphylococcus aureus*
- *Klebsiella pneumoniae*
- *Actinobacillus pleuropneumoniae*
- *Chromobacterium violaceum*
- *Blautia producta*
- *Hungatella hathewayi*
- *Prevotella copri*

Yeast

- *Saccharomyces cerevisiae*
- *Schizosaccharomyces pombe*
- *Pichia pastoris*
- *Yarrowia lipolytica*
- *Kluyveromyces lactis*
- *Hansenula polymorpha*
- *Ustilago maydis*

Filamentous organisms

- *Aspergillus fumigatus*
- *Aspergillus nidulans*
- *Aspergillus niger*
- *Streptomyces acidiscabies*
- *Streptomyces venezuelae*
- *Trichoderma reesei*

Archaea

- *Haloferax volcanii*
- *Sulfolobus acidocaldarius*

Anaerobic organisms

- *Acetobacterium woodii*
- *Clostridium acetobutylicum*
- *Clostridium ljungdahlii*
- *Clostridium difficile*

Phototrophic organisms

- *Chlorella vulgaris*
- *Scenedesmus obliquus*
- *Synechococcus elongatus*
- *Nicotiana tabacum* BY-2 (plant cells)

The CGQ technology has already been used in over 30 publications in renowned journals.

Example Publications

Bruder et al. *Microb Cell Fact* (2016) 15:127
DOI 10.1186/s12934-016-0526-3

Microbial Cell Factories

TECHNICAL NOTES Open Access

Parallelised online biomass monitoring in shake flasks enables efficient strain and carbon source dependent growth characterisation of *Saccharomyces cerevisiae*

Stefan Bruder¹, Mara Reifenrath¹, Thomas Thomik¹, Eckhard Boles¹ and Konrad Herzog^{2*}

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Article | Open Access | Published: 08 June 2021

The archaeal protein SepF is essential for cell division in *Haloferax volcanii*

Phillip Nußbaum, Maren Gerstner, Marie Dingethal, Celine Erb & Sonja-Verena Albers

 Journal of Bioscience and Bioengineering
Volume 130, Issue 3, September 2020, Pages 272–282

Poly-γ-glutamic acid production by *Bacillus subtilis* 168 using glucose as the sole carbon source: A metabolomic analysis

Birthe Halmischlag¹, Sastia Prama Putri², Eiichiro Fukusaki², Lars Mathias Blank¹

Effect of sigma E on carbapenem resistance in OXA-48-producing *Klebsiella pneumoniae*

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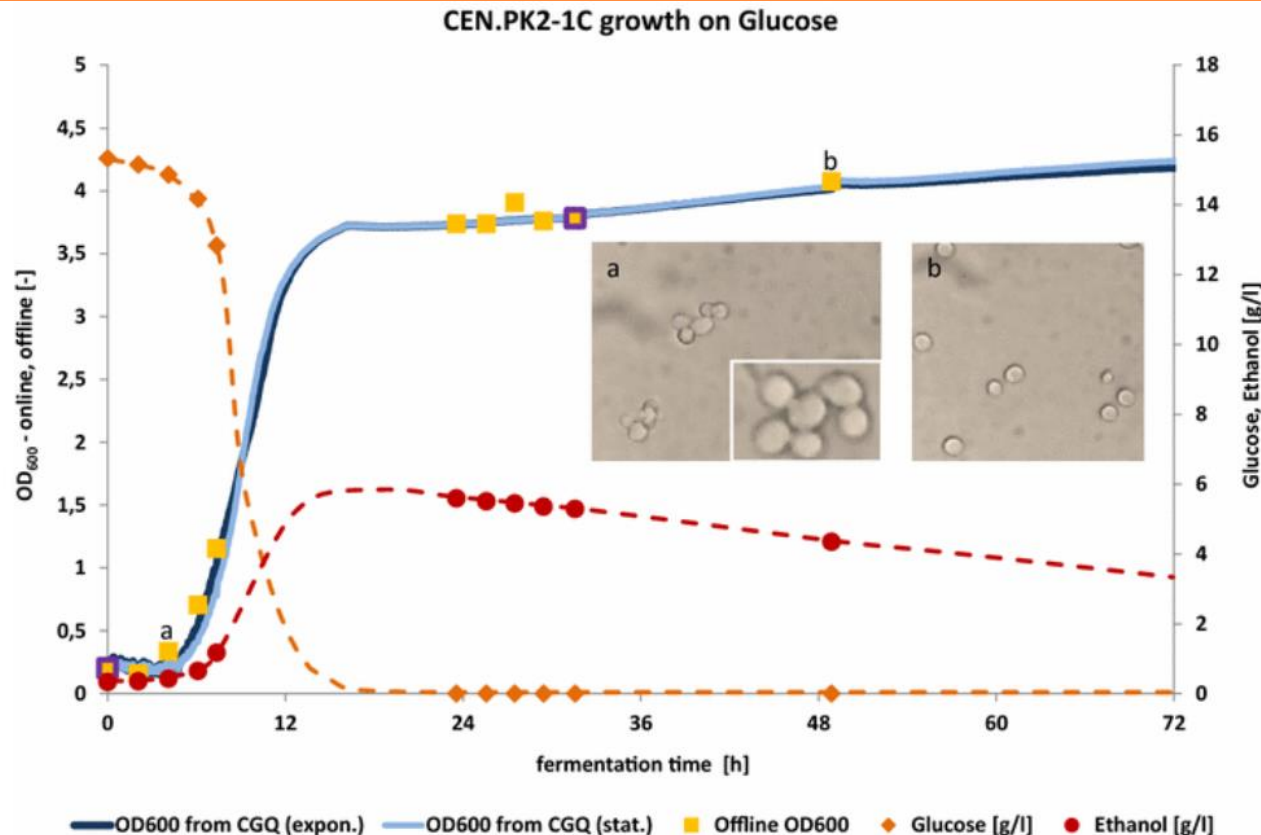
Martina Cremanns, Felix Lange, Sören G. Gatermann, Niels Pfennigwerth

Journal of Antimicrobial Chemotherapy, Volume 77, Issue 6, June 2022, Pages 1578–1585, <https://doi.org/10.1093/jac/dkac078>

Published: 10 March 2022 Article history ▾

The online biomass data generated by the CGQ correlates nicely with offline OD data.

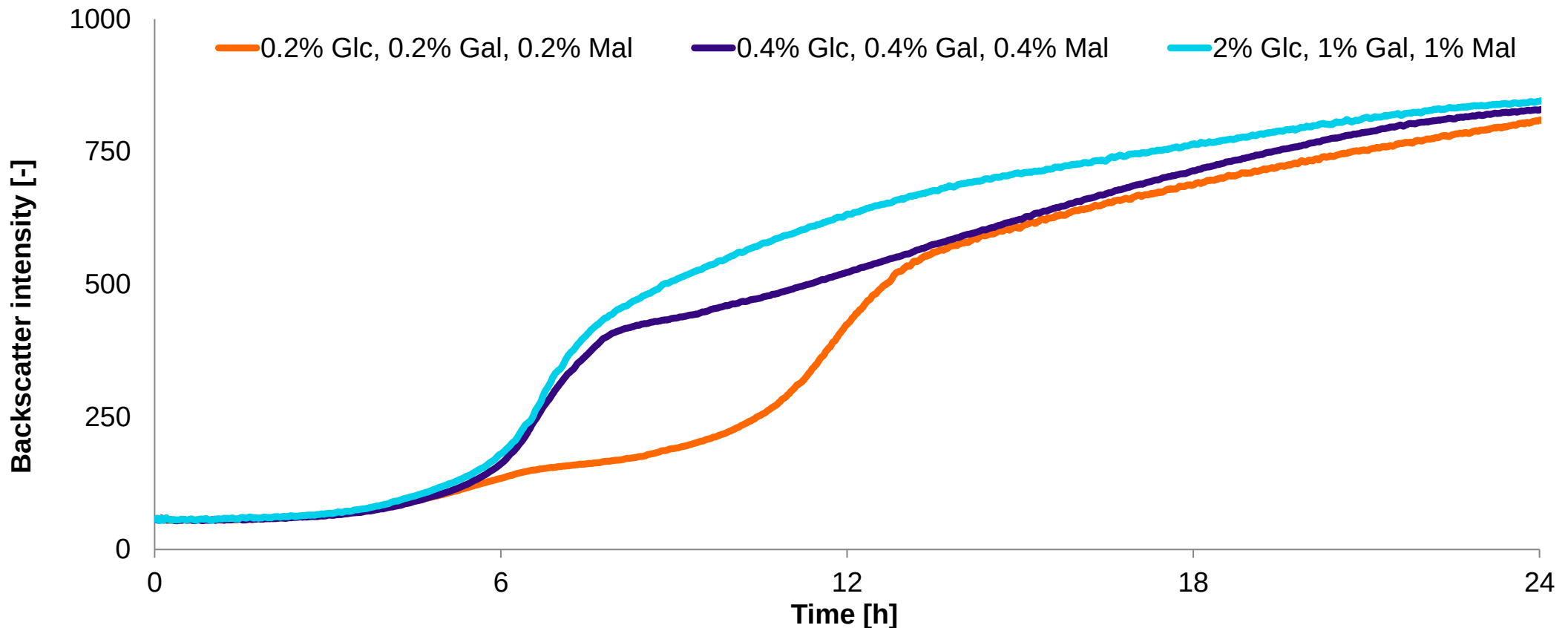
OD & CGQ Measurements (OD Calibrated): *Saccharomyces cerevisiae*



Bruder *et al.* (2016): Parallelised online biomass monitoring in shake flasks enables efficient strain and carbon source dependent growth characterisation of *Saccharomyces cerevisiae* (Microbial Cell Factories).

The CGQ is ideal for screening experiments in shake flasks such as media optimizations.

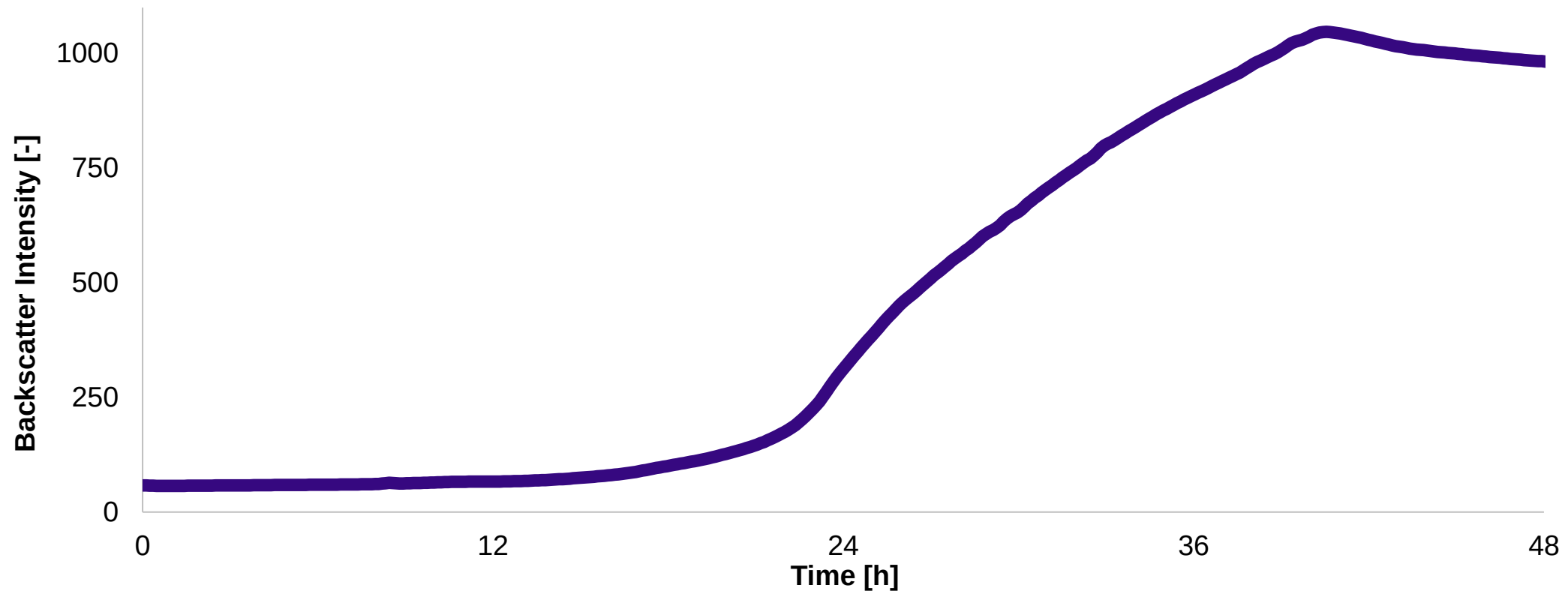
CGQ Measurements: *Saccharomyces cerevisiae* CEN.PK2.-1C Growing on Mixed Carbon Sources



Saccharomyces cerevisiae CEN.PK2.-1C, 50 mL Minimal Media, 300 mL Shake Flasks, 30 °C, 180 rpm

The CGQ is capable of precisely monitoring *Pichia pastoris* cultures in shake flasks.

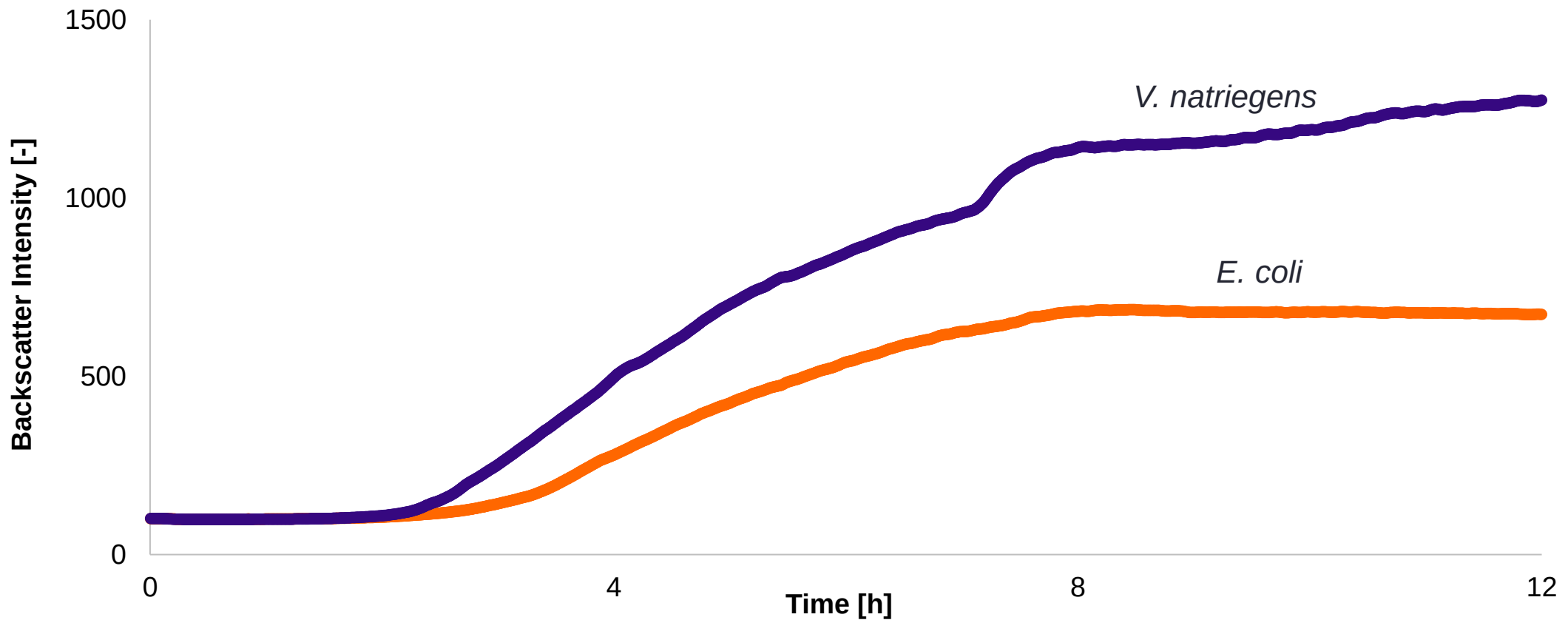
CGQ Measurements: *Pichia pastoris*



Pichia pastoris, 25 mL BMMY Media, 250 mL Shake Flask, 28 °C, 225 rpm

The CGQ is ideal for growth rate comparisons of different organisms, for example *Vibrio natriegens* versus *Escherichia coli*.

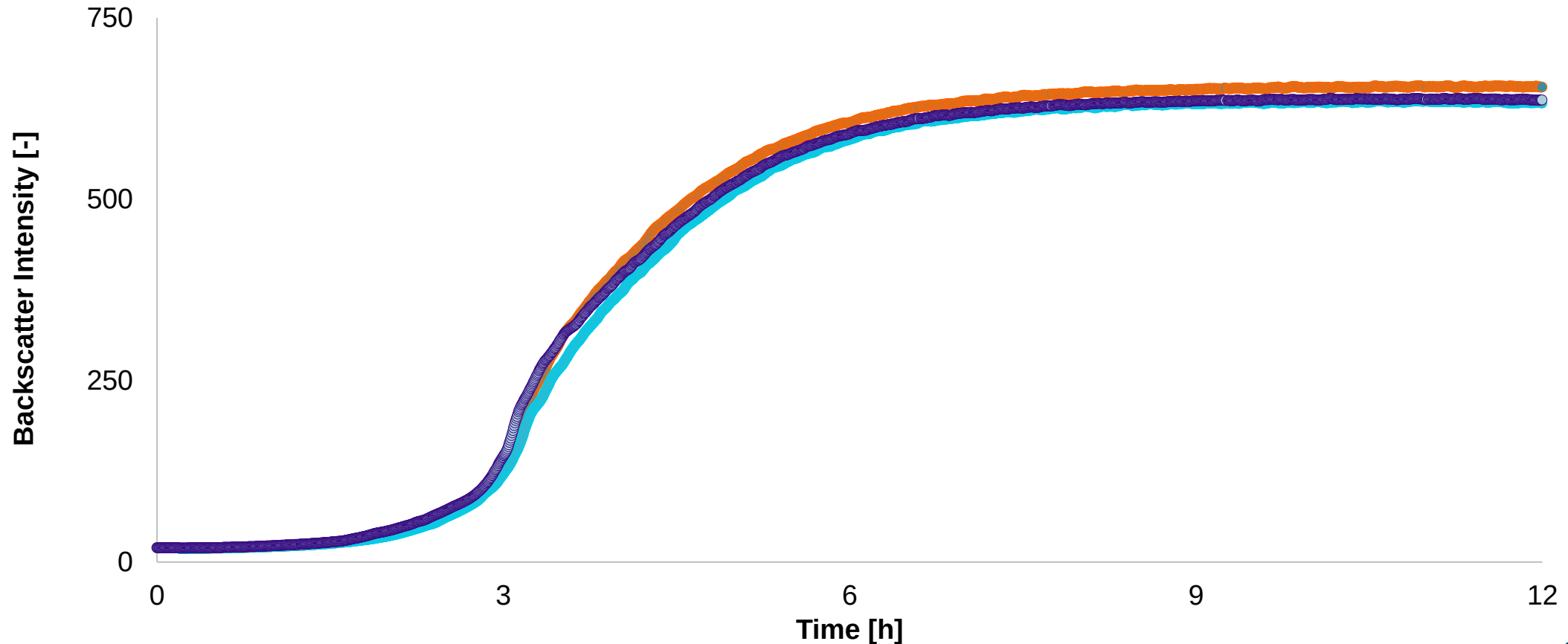
CGQ Measurements: *Vibrio natriegens* and *Escherichia coli*



Escherichia coli & *Vibrio natriegens*, 25 mL LB Media (Vibrio: + V2 Salts), 250 mL Shake Flasks, 37 °C, 180 rpm

The CGQ is capable of precisely monitoring *Corynebacterium glutamicum* cultures in shake flasks.

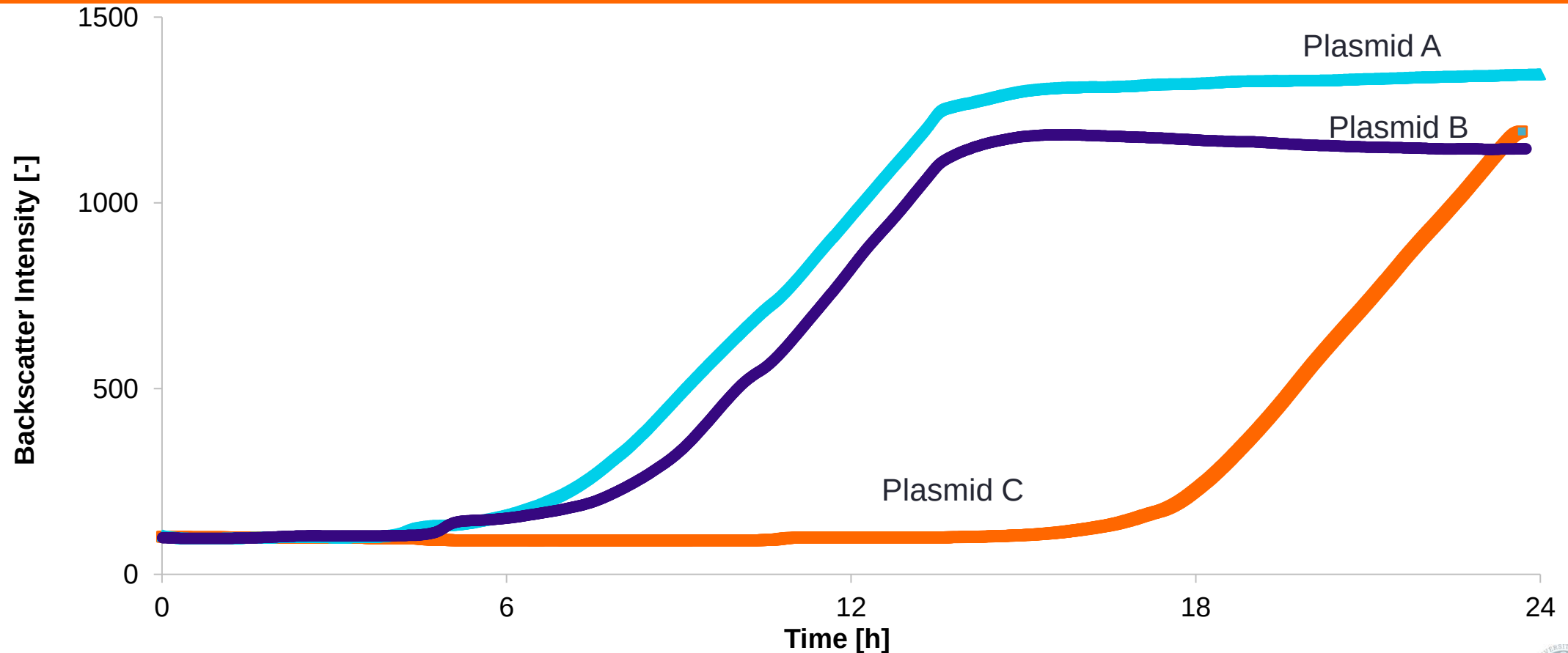
CGQ Measurements: *Corynebacterium glutamicum* Triplicates



Corynebacterium glutamicum, 25 mL LB Media, 250 mL Shake Flasks, 30 °C, 250 rpm

The CGQ is ideal for quick and easy growth comparisons of different *Pseudomonas putida* cultures.

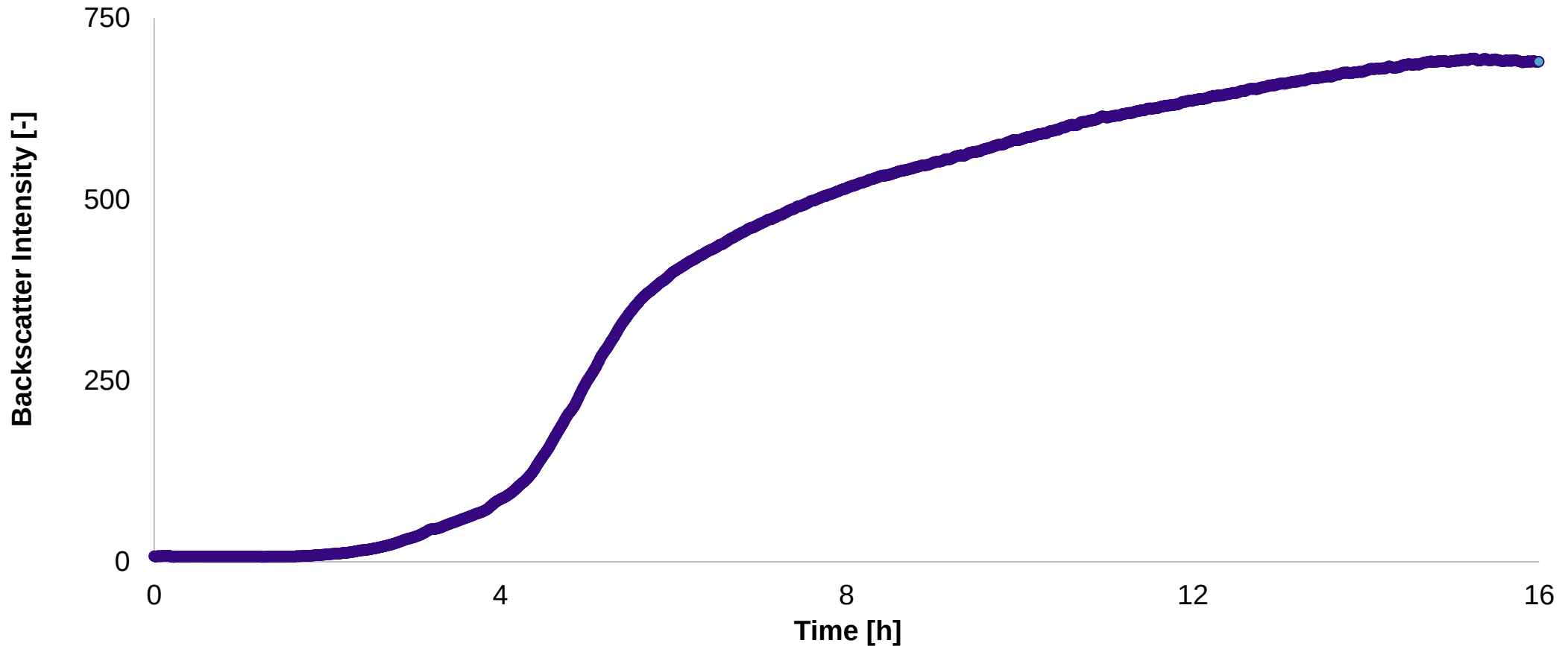
CGQ Measurements: *Pseudomonas putida* Transformed with Different Plasmids



Pseudomonas putida, 25 mL Willems KPI Media, 250 mL Shake Flasks, 30 °C, 200 rpm

The CGQ is capable of precisely monitoring *Bacillus subtilis* cultures in shake flasks.

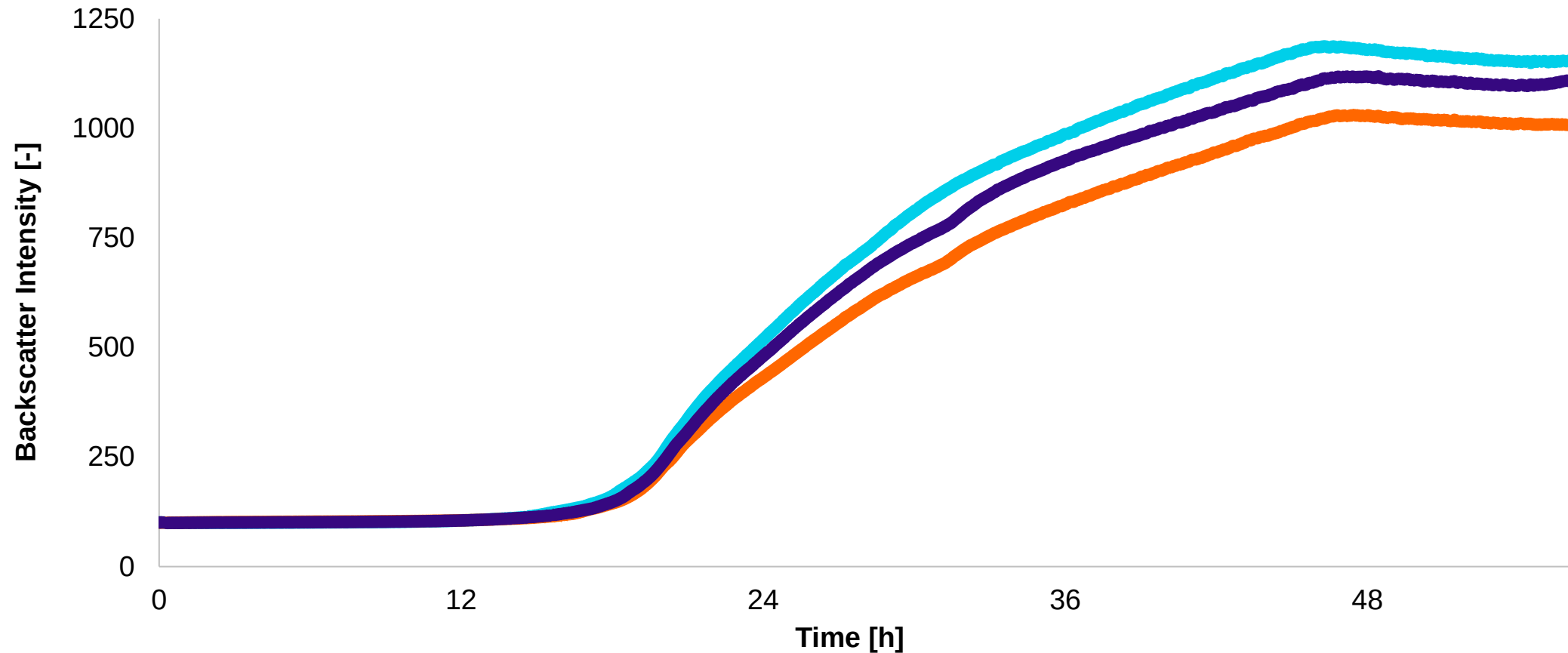
CGQ Measurement: *Bacillus subtilis*



Bacillus subtilis, 25 mL LB Media, 250 mL Shake Flask, 37 °C, 250 rpm

The CGQ is capable of precisely monitoring filamentous *Aspergillus niger* cultures in shake flasks.

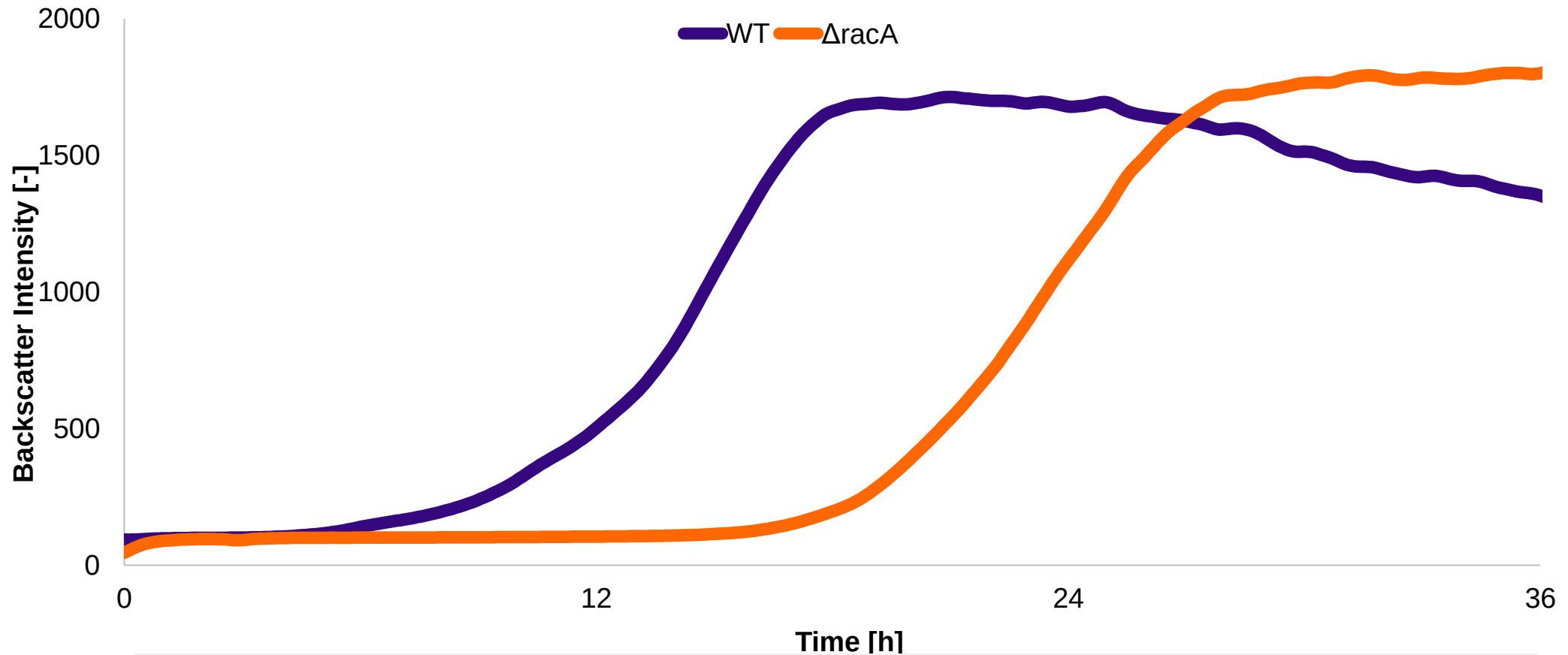
CGQ Measurement: *Aspergillus niger* Triplicates



Aspergillus niger, 50 mL LB Media, 250 mL Shake Flasks, 25 °C. 250 rpm

The CGQ is the perfect tool for screening experiments with *Aspergillus niger* in shake flasks.

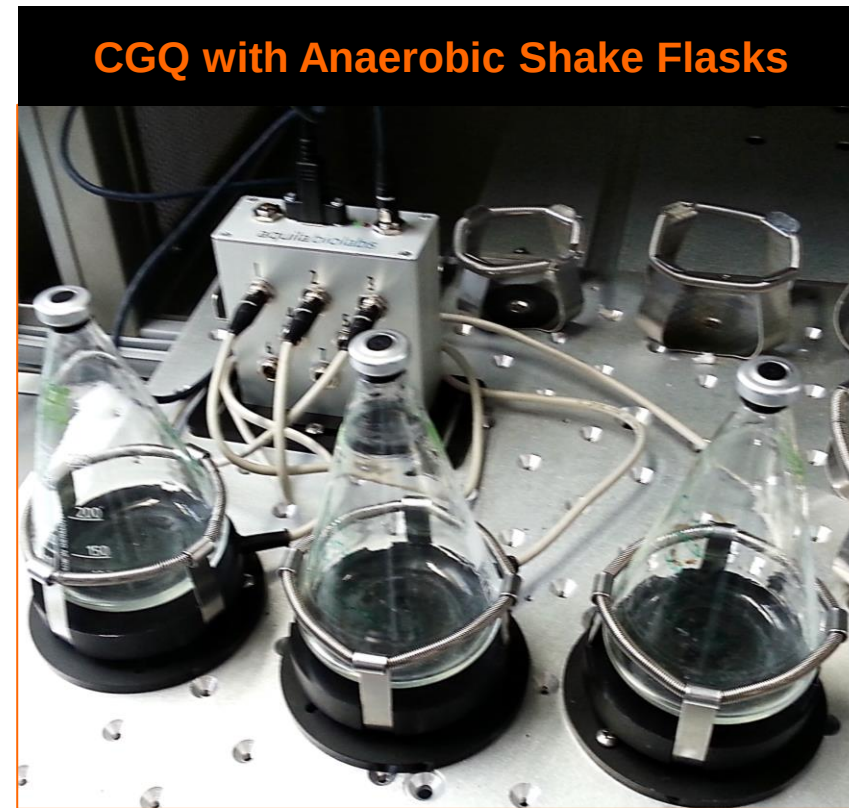
CGQ Measurements: *Aspergillus niger* N402



Aspergillus niger N402, 50 mL Culture Media (CM), 250 mL Shake Flask, 30 °C, 200 rpm

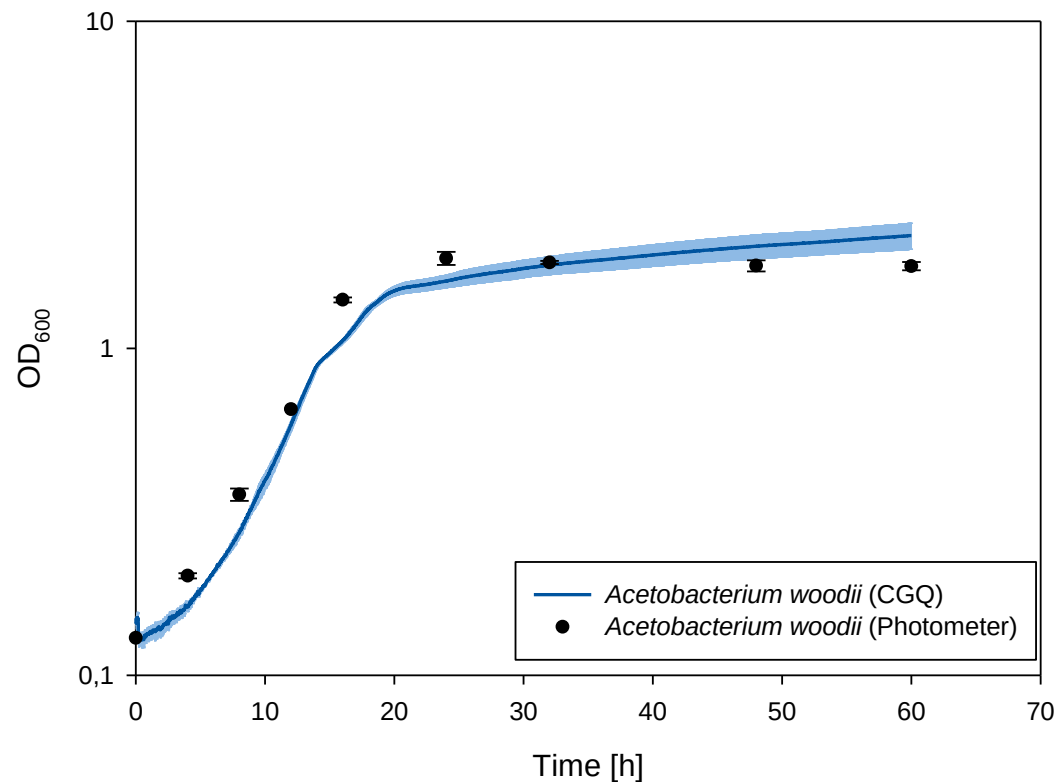
The CGQ is fully compatible with all typical anaerobic cultivation vessels such as serum bottles, Schott flasks or anaerobic shake flasks.

CGQ for Anaerobic Cultivation Vessels



The CGQ is capable of precisely monitoring *Acetobacterium woodii* cultures in serum bottles and shows good OD correlation.

CGQ & OD₆₀₀ Measurements: *Acetobacterium woodii* Triplicates



Acetobacterium woodii, 50 mL Acetobacterium Medium (+ Fructose), 100 mL Serum Bottle, 30 °C, 250 rpm

Always mount and route the CGQ cables inside the shaker to prevent strain on the cables during the shaking movement.

Cable Management Inside The Shaker

Ensure enough slack before connecting cables to the CGQ Hub.



Guide the cables using the cable clamp array.



Our products and our service are highly valued by our global customer base.

Customer Feedback

For the first time, **we were able to generate high-quality growth curves** of photosynthetic *S. elongatus* without necessarily relying on **classical manual measurements like OD₇₅₀ or cell dry weight**,(...). Thus, we don't face the omnipotent risk of contamination anymore.

Prof. Dr. Ilka Maria Axmann



The CGQ **provided accurate growth curves with a very dense sampling interval** and gave us the opportunity to identify differences in the growth behaviors. The **CGQ (...) had a big impact in** understanding the organisms and, eventually, the finalization of the publication.”

Prof. Dr. Lars Blank



“The CGQ made it possible for us to observe growth dynamics in real-time (...). This has very **much improved performance and reproducibility of our experiments**, and it has **increased our throughput considerably**.”

Dr. Andrea Sass



“ (...) We are **also very satisfied about the customer service** provided: They really thought along with us to adapt the system for monitoring the growth of (hyper)thermophiles.“

Prof. Dr. E. Peeters





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insights@scientificbio.com
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