



# Cell Growth Quantifier (CGQ)

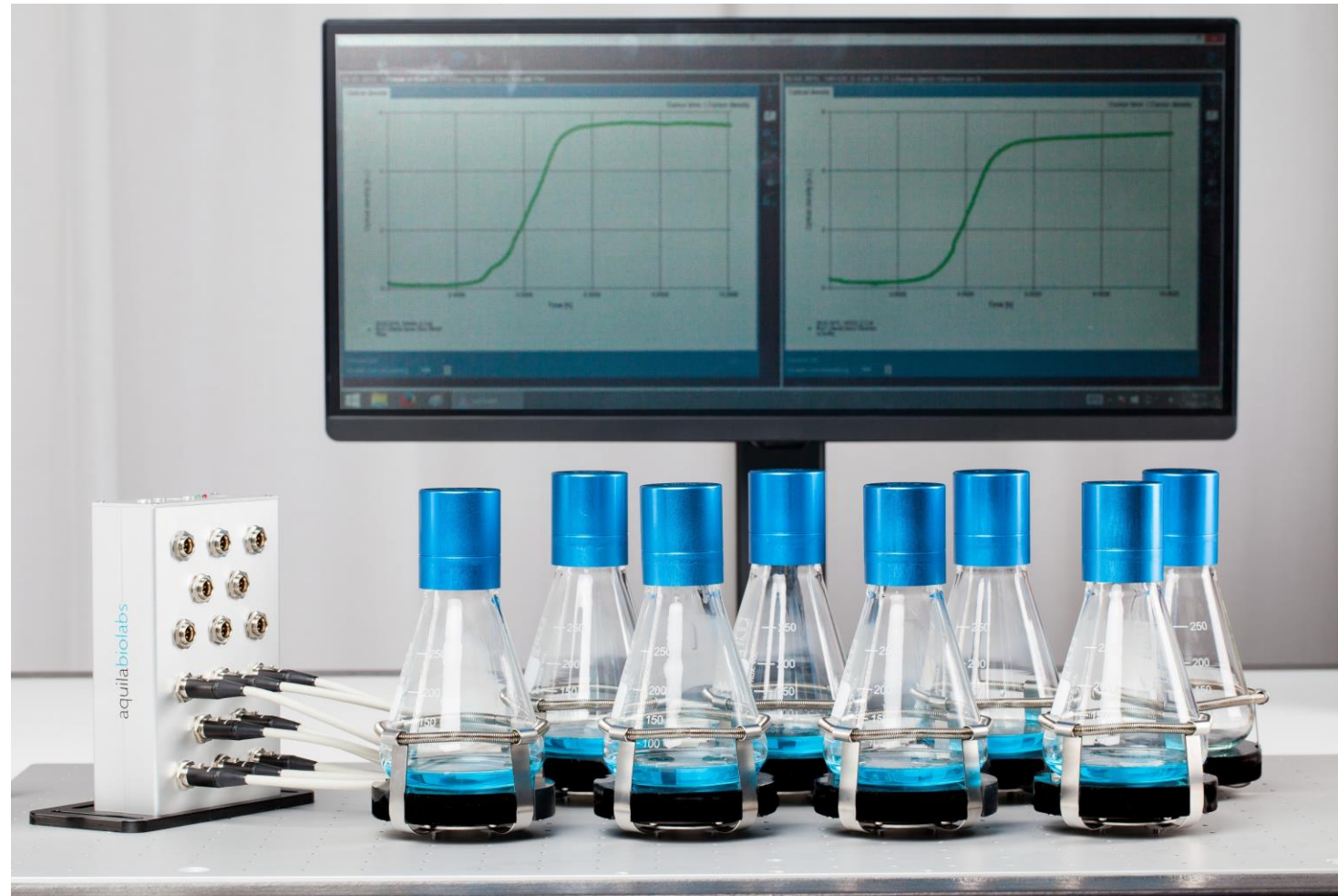
Online Biomass Monitoring in Shake Flasks

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The Cell Growth Quantifier (CGQ) is a bioprocess analytical technology allowing for non-invasive online biomass monitoring in shake flask cultures.

## The CGQ Technology

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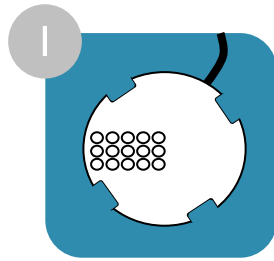


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A CGQ system consists of three components:  
The sensor plates, the base station and the software CGQuant.

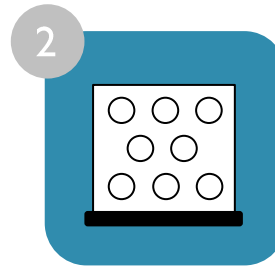
### Components of the CGQ System

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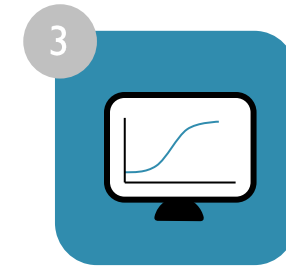
Sensor Plate

The sensor plates are positioned under the shake flask and measure the biomass non-invasively.



Base Station

The base station bundles the data from all monitored flasks and sends it to the software CGQuant.

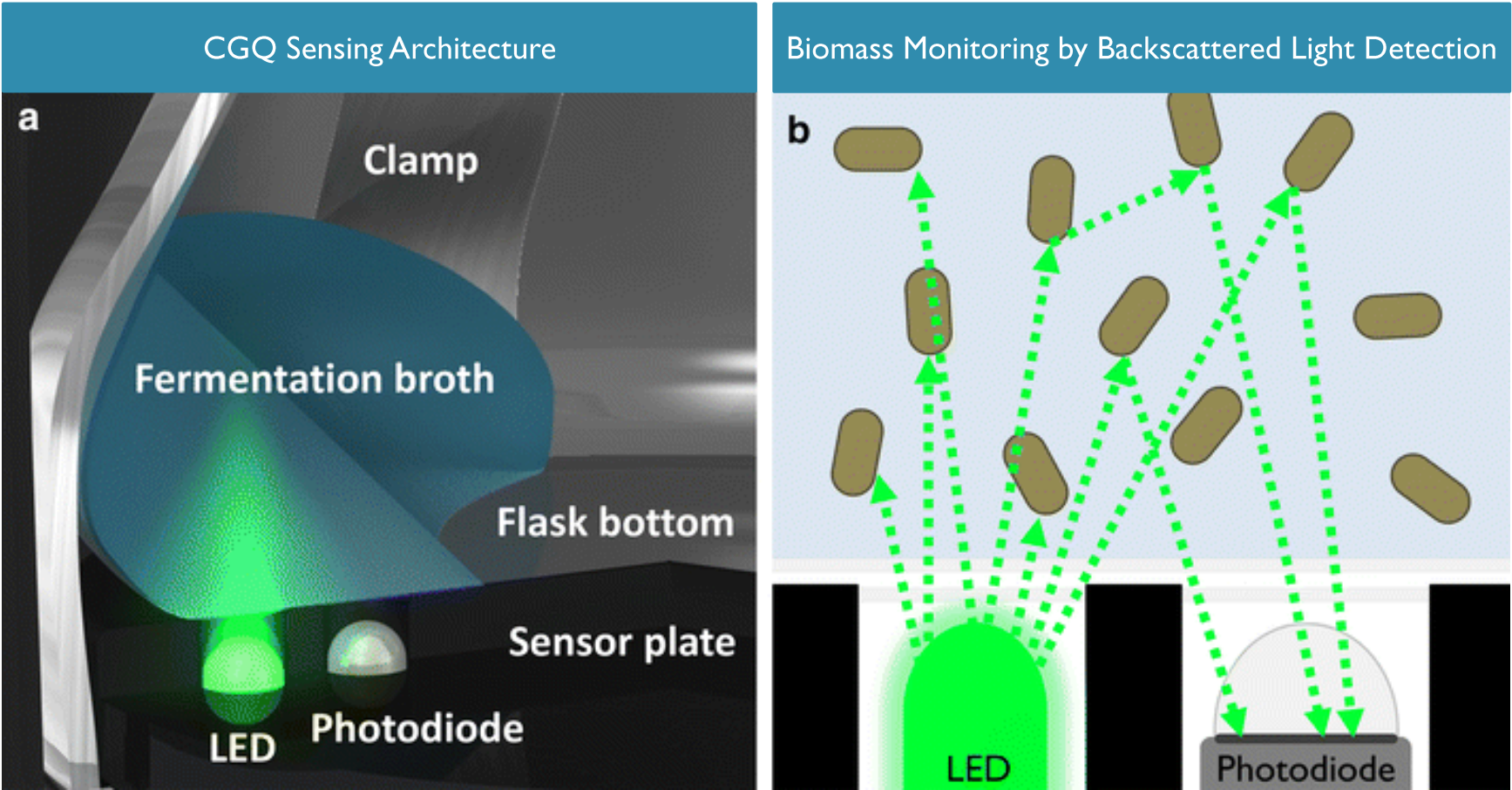


CGQuant

The software CGQuant analyzes and visualizes the biomass signal from all monitored shake flasks.

The CGQ implements a dynamic approach of backscattered light measurement, allowing for accurate biomass monitoring in shaken cultures.

The Principle of Measurement



aquila biolabs has developed a sensor capable of monitoring biomass non-invasively through the glass wall of a shake flask.

### 100 ml Sensor Plate

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aquila biolabs' universal adapter system allows the customer to use the same sensor for various shake flask sizes.

The Model „One sensor for all shake flask sizes“



100 ml Sensor Plate



250 ml Universal Adapter



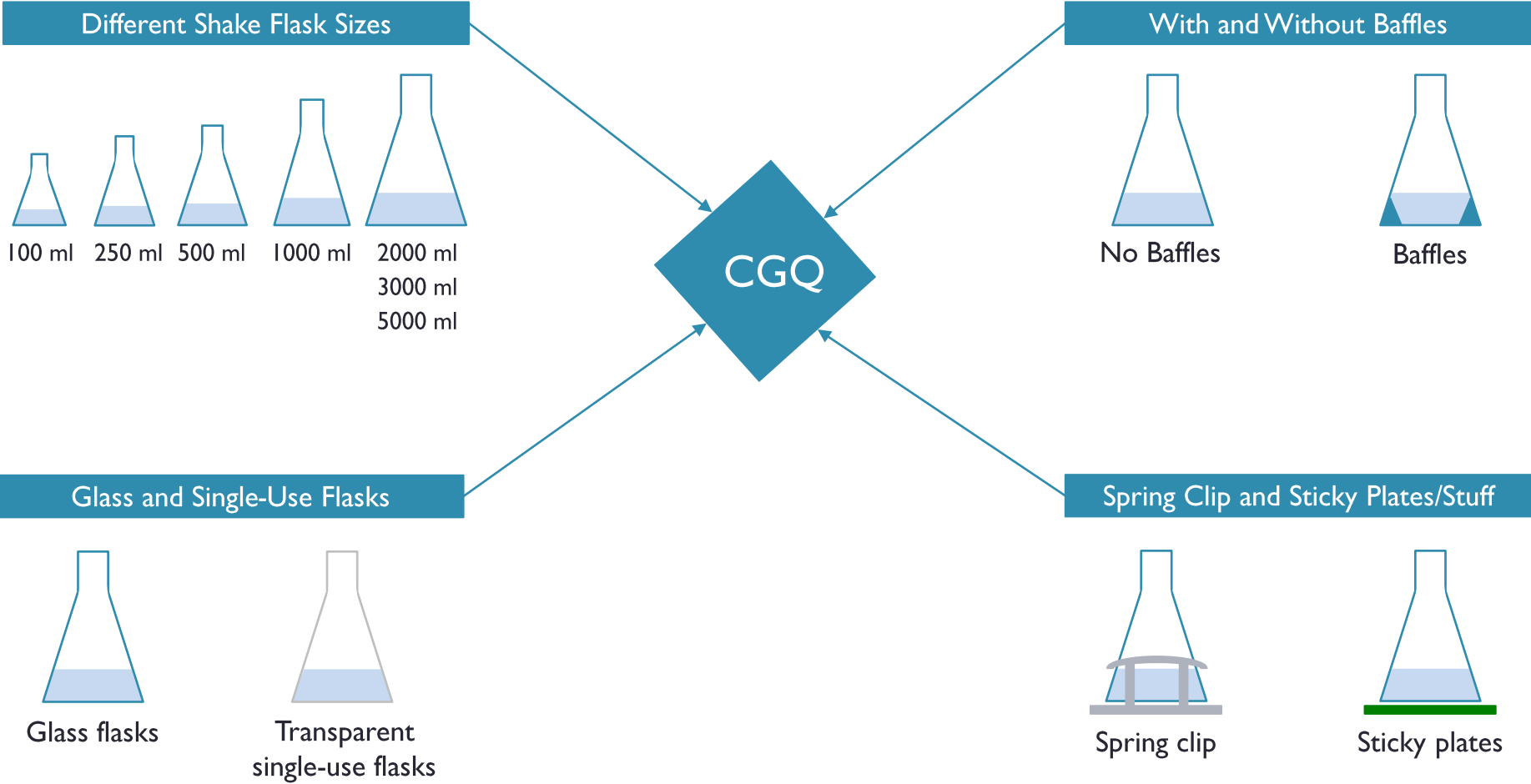
Sensor Plate for 250 ml Flask

Advantages

- Maximum flexibility: the same sensor plate can be used for different shake flask sizes.
- If an existing customer decides to monitor other flask sizes at one point, he now only needs to invest into adapters instead of buying additional sensor plates.

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

Compatible Laboratory Infrastructure



Various organisms ranging from bacteria and archaea over filamentous fungi and yeast to microalgae have been successfully monitored with the CGQ technology.

## Successfully Monitored Organisms

### 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*
- *Hungtarella 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 aetobutylicum*
- *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 for several publications in renowned journals.

## Exemplary Publications

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

Microbial Cell Factories


TECHNICAL NOTES Open Access

 CrossMark

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


Stefan Bruder<sup>1</sup>, Mara Reifenrath<sup>1</sup>, Thomas Thomik<sup>1</sup>, Eckhard Boles<sup>1</sup> and Konrad Herzog<sup>2\*</sup>

Appl Microbiol Biotechnol  
DOI 10.1007/s00253-017-8220-x

 CrossMark

BIOTECHNOLOGICAL PRODUCTS AND PROCESS ENGINEERING

**De novo biosynthesis of *trans*-cinnamic acid derivatives in *Saccharomyces cerevisiae***


Manuela Gottardi<sup>1</sup> · Jan Dines Knudsen<sup>2,3</sup> · Lydie Prado<sup>4</sup> · Mislav Oreb<sup>1</sup>  · Paola Branduardi<sup>2</sup> · Eckhard Boles<sup>1</sup>

Received: 14 November 2016 / Revised: 13 February 2017 / Accepted: 4 March 2017  
© Springer-Verlag Berlin Heidelberg 2017

Bracharz et al. *BMC Biotechnology* (2017) 17:27  
DOI 10.1186/s12896-017-0348-3

BMC Biotechnology

RESEARCH ARTICLE Open Access



 CrossMark

**The effects of TORC signal interference on lipogenesis in the oleaginous yeast *Trichosporon oleaginosus***

Felix Bracharz, Veronika Redai, Kathrin Bach, Farah Qoura and Thomas Brück\*

Biochemical Engineering Journal 120 (2017) 103–112

Contents lists available at ScienceDirect

 ELSEVIER 

Biochemical Engineering Journal


journal homepage: [www.elsevier.com/locate/bej](http://www.elsevier.com/locate/bej)

Regular article

**Improvement of the yeast based (*R*)-phenylacetylcarbinol production process via reduction of by-product formation**

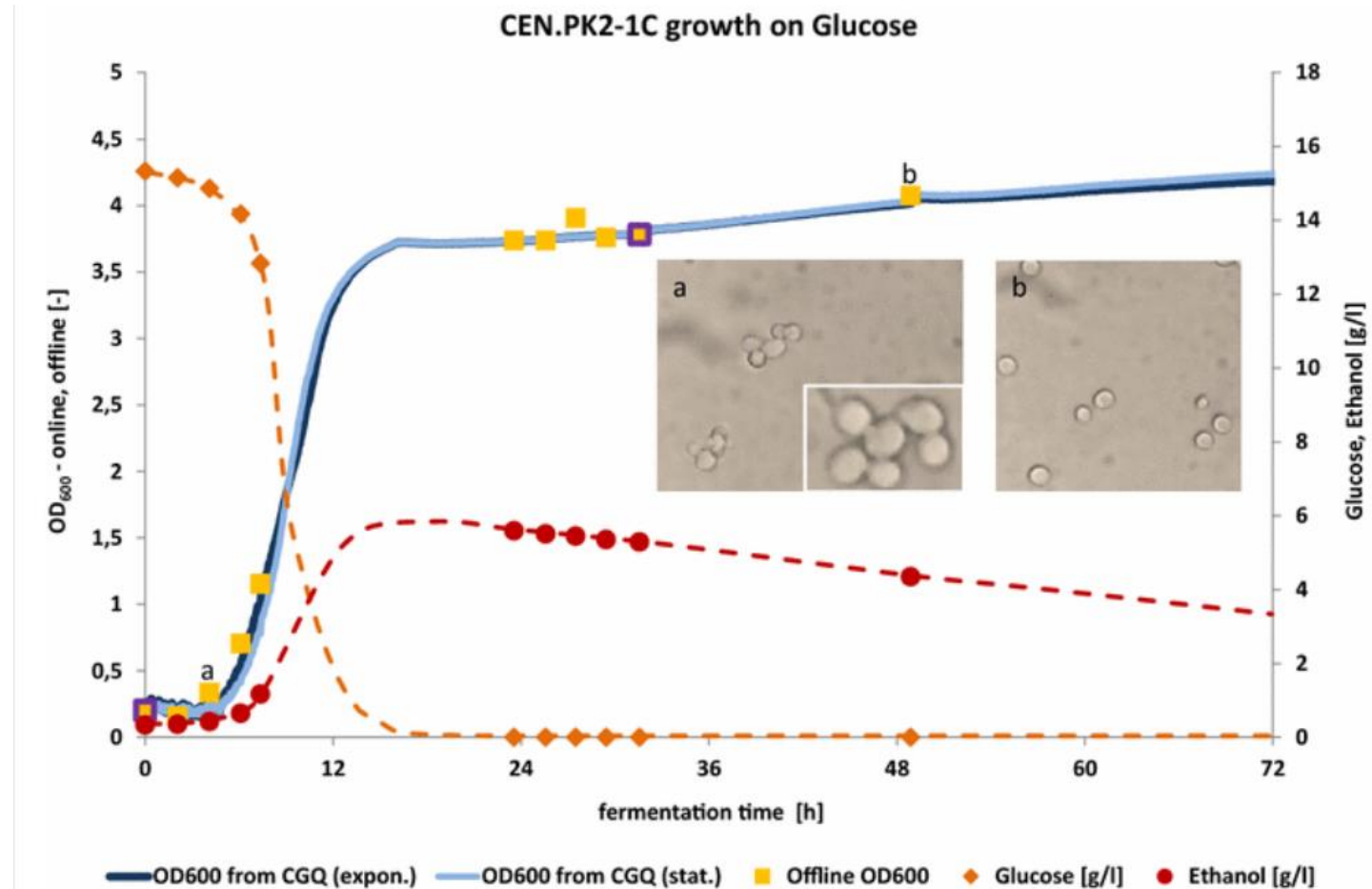
Stefan Bruder, Eckhard Boles\*

Goethe University Frankfurt, Institute of Molecular Biosciences, 60438 Frankfurt am Main, Germany

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

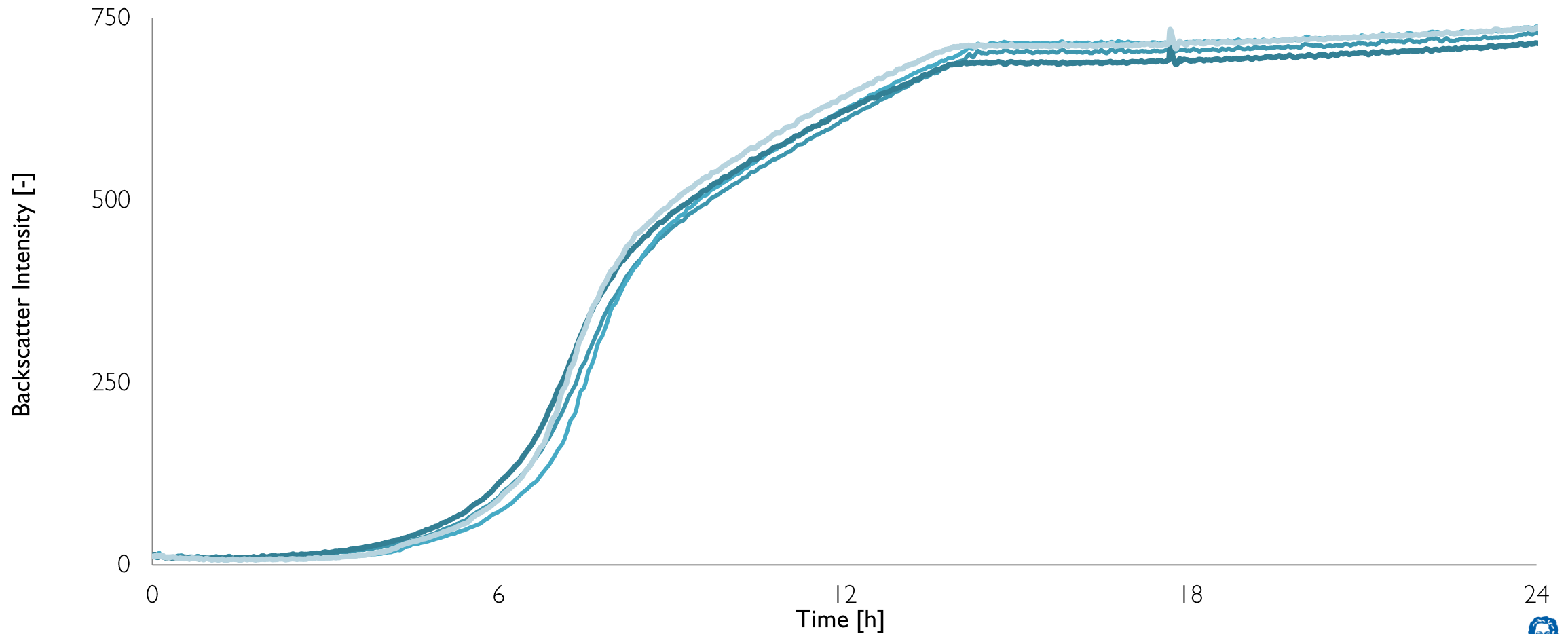
OD & CGQ Measurements (OD Calibrated): *Saccharomyces cerevisiae*



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 allows for highly precise und reproducible biomass measurements in shake flasks.

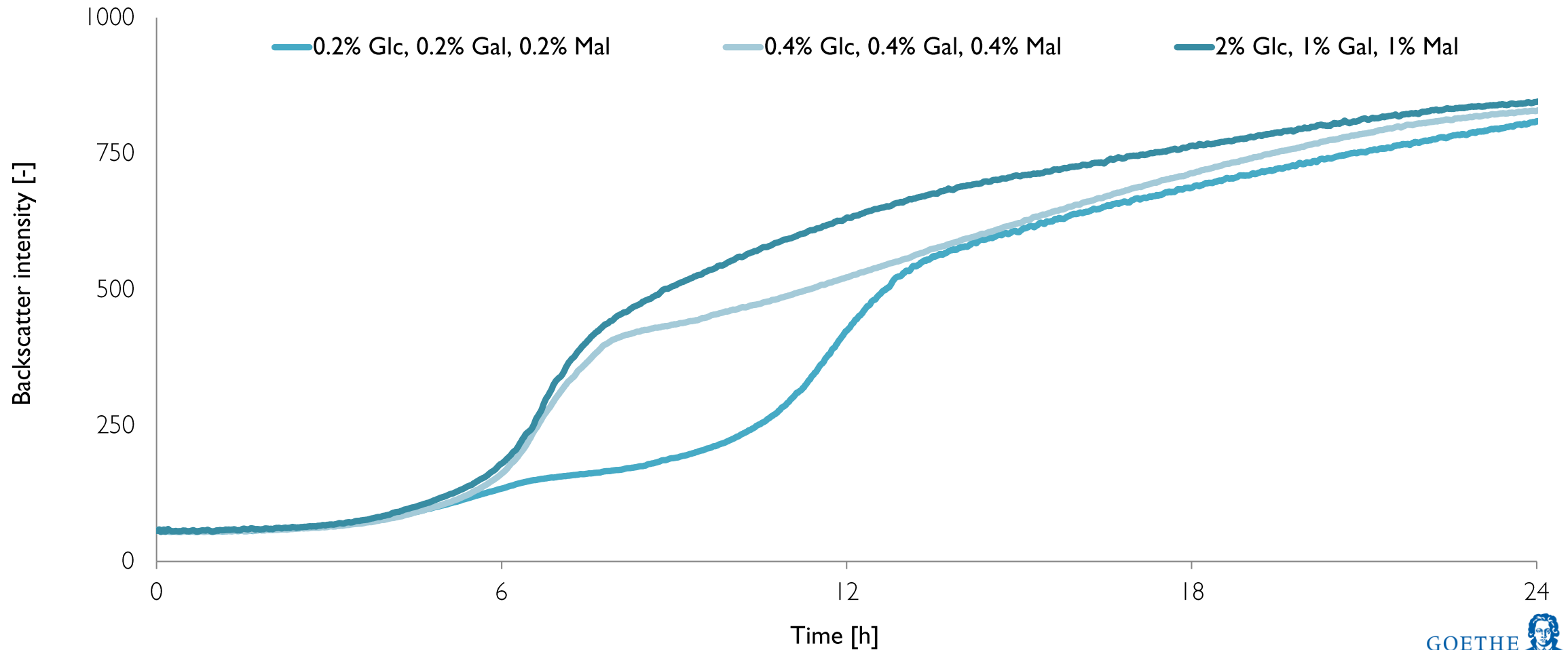
### CGQ Measurements: Four *Saccharomyces cerevisiae* Replicates



*Saccharomyces cerevisiae* CEN.PK2.-1C, 50 ml Minimal Medium, 300 ml Shake Flasks, 30 °C, 180 rpm

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

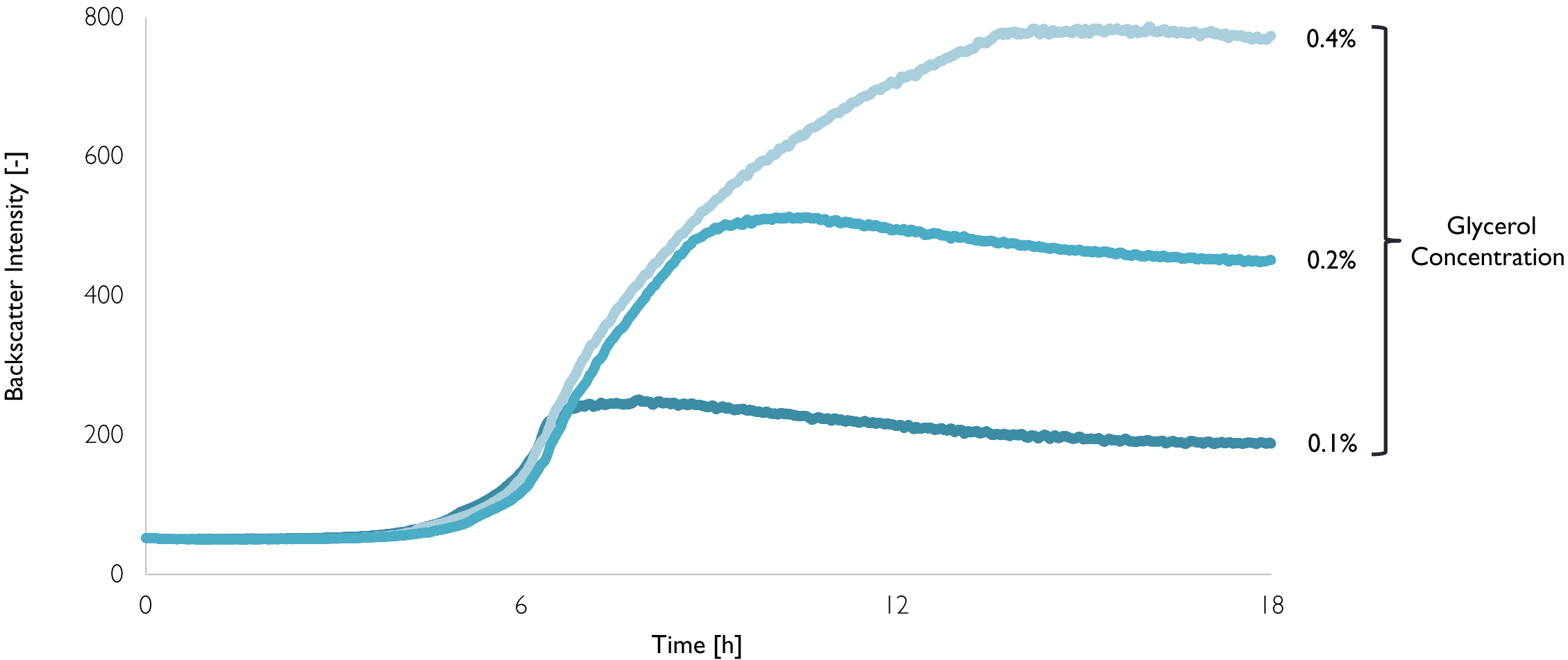
CGQ Measurements: *Saccharomyces cerevisiae* CEN.PK2.-1C Growing on Mixed Carbon Sources



*Saccharomyces cerevisiae* CEN.PK2.-1C, 50 ml Minimal Medium, 300 ml Shake Flasks, 30 °C, 180 rpm

Parallelized online biomass monitoring with the CGQ allows for efficient screenings and growth characterizations.

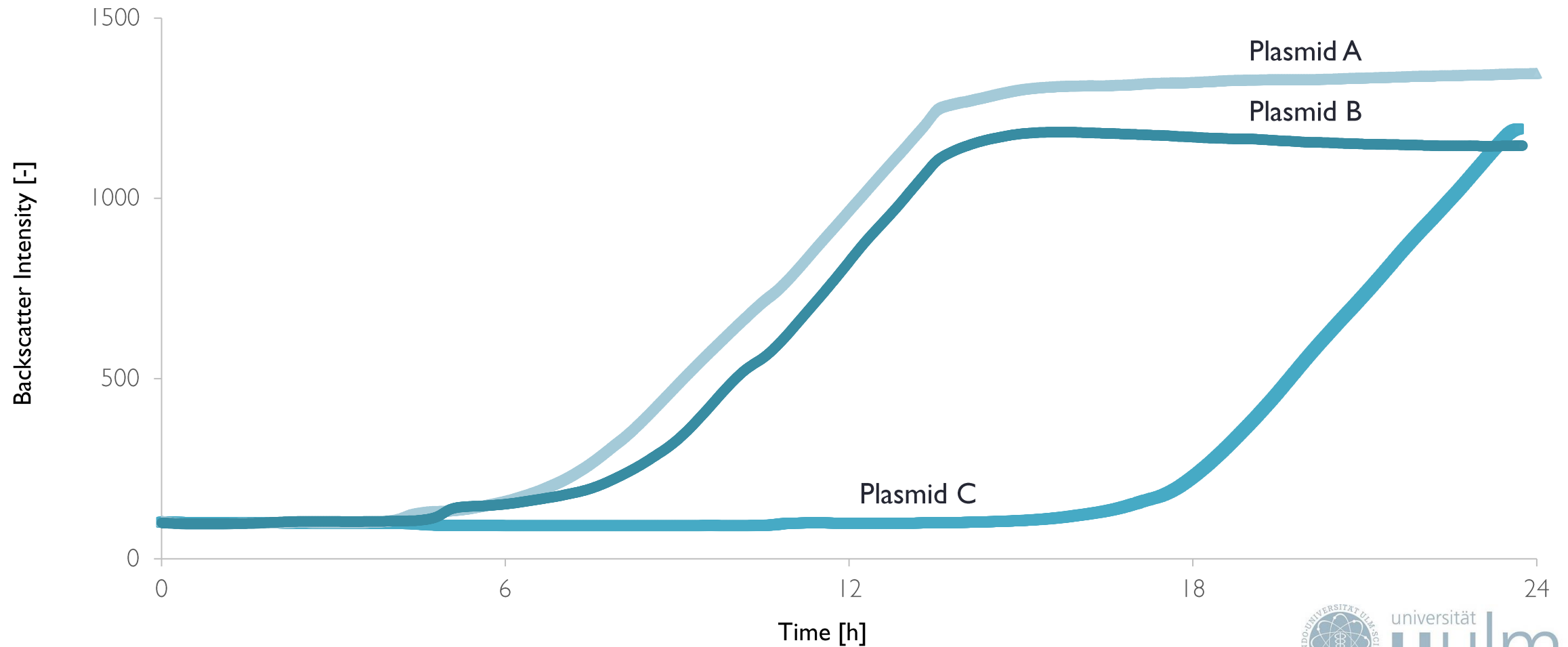
CGQ Measurements: *Escherichia coli* Growing on Different Glycerol Concentrations



*Escherichia coli* BL21-Gold (DE3) pET28a(+) EGFP Kan<sup>R</sup>, 25 ml M9 Medium (+ 0.25 % Casamino Acids), 250 ml Shake Flasks, 37 °C, 250 rpm

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

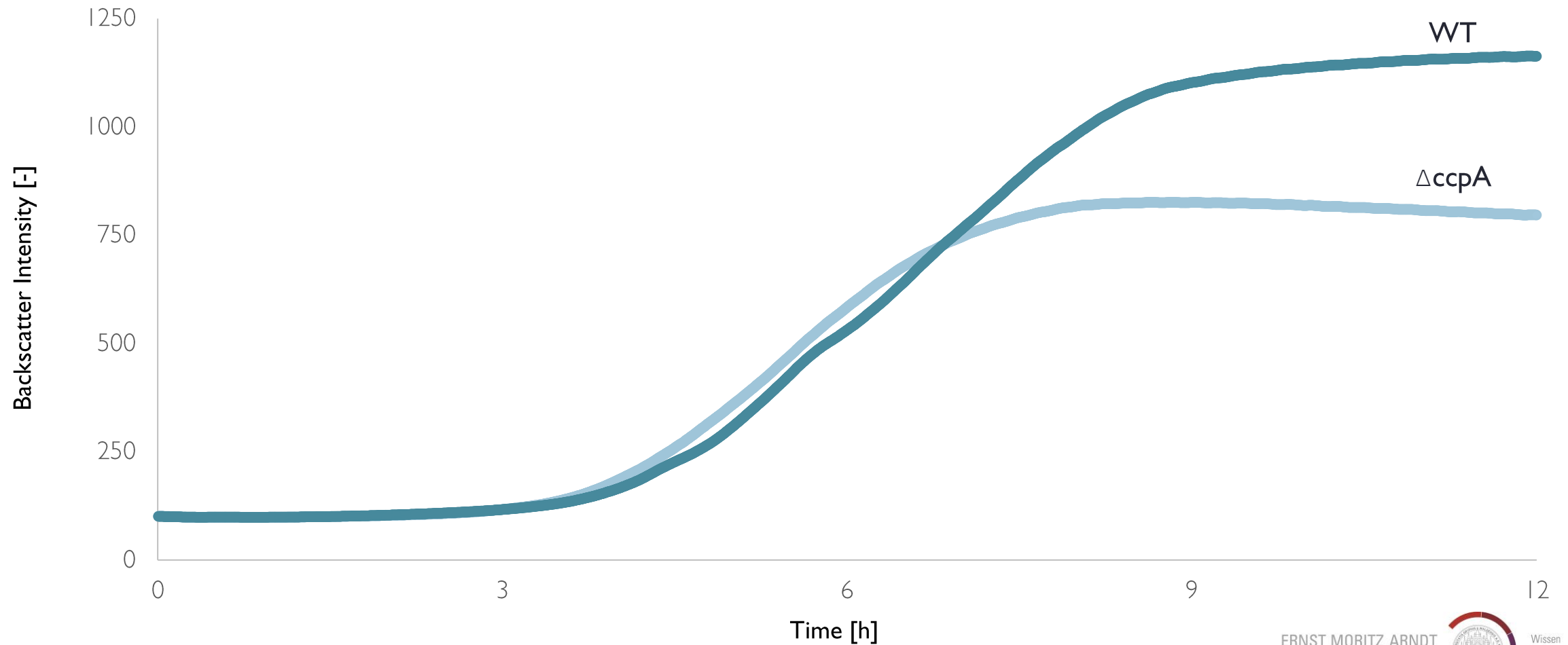
### CGQ Measurements: *Pseudomonas putida* Transformed with Different Plasmids



*Pseudomonas putida*, 25 ml Willems KPI Medium, 250 ml Shake Flasks, 30 °C, 200 rpm

The CGQ is capable of precisely monitoring *Staphylococcus aureus* cultures in shake flasks.

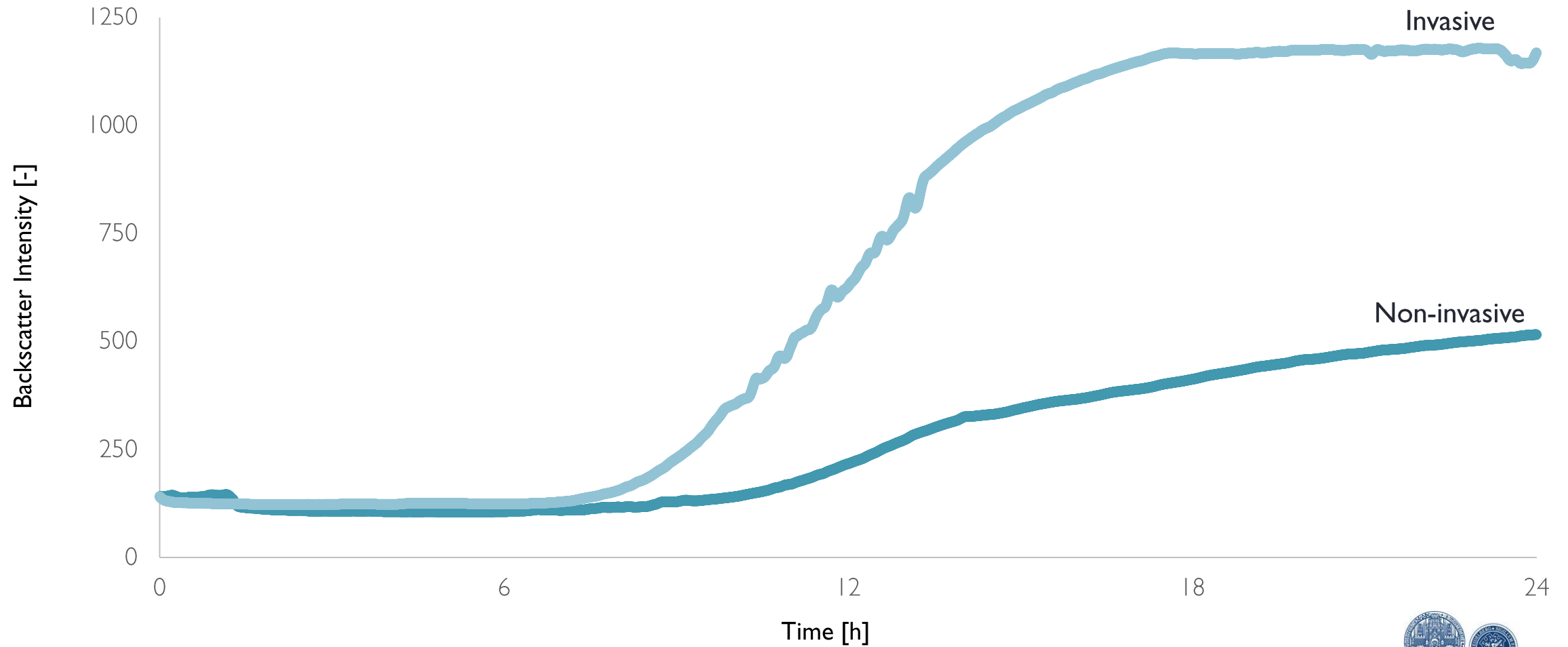
### CGQ Measurements: *Staphylococcus aureus* Wild Type and Deletion Mutant



*Staphylococcus aureus*, 20 ml LB Medium, 100 ml Shake Flasks, 37 °C, 180 rpm

The CGQ is capable of precisely monitoring *Staphylococcus aureus* cultures in shake flasks.

### CGQ Measurements: Invasive and Non-Invasive *Staphylococcus aureus* Strain



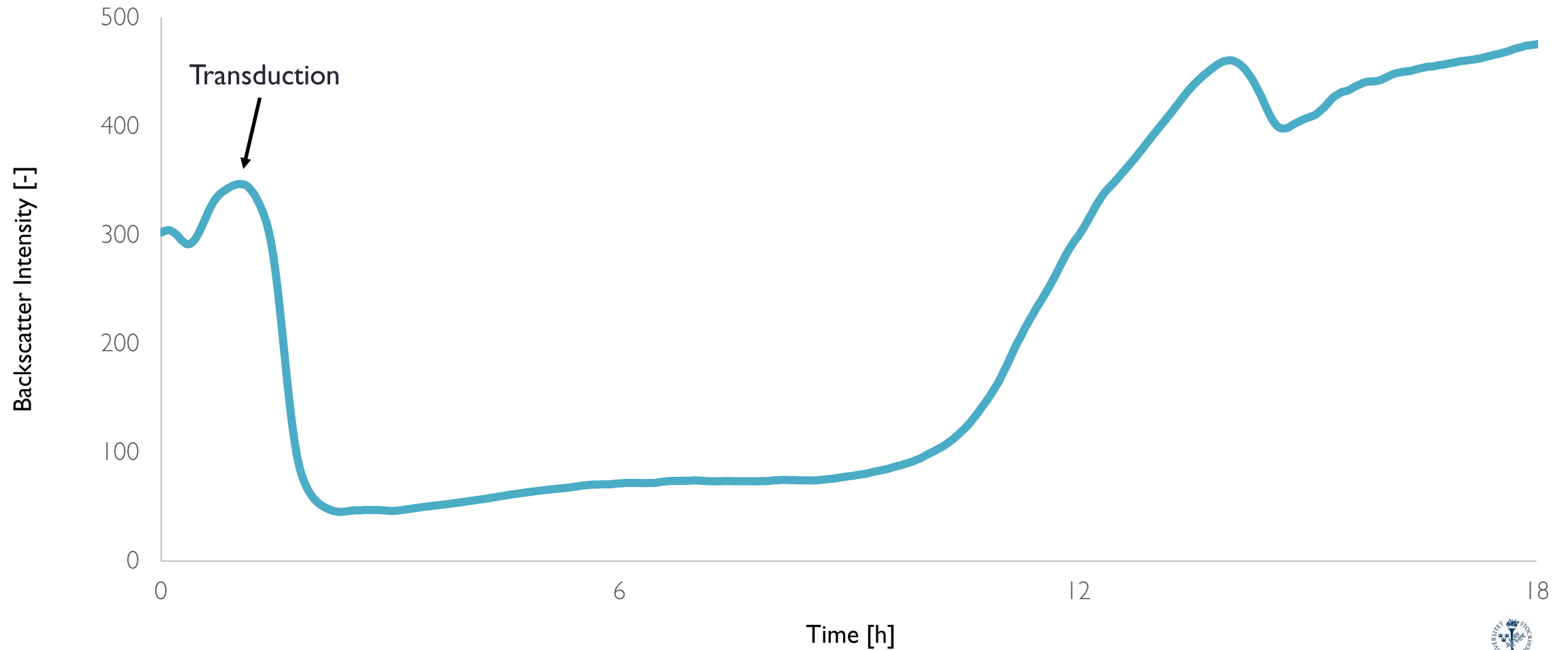
*Staphylococcus aureus*, 10 ml TSB Medium, 100 ml Shake Flasks, 37 °C, 200 rpm





The CGQ is capable of precisely monitoring transduction of *Klebsiella pneumoniae* by phages

### CGQ Measurements: *Klebsiella pneumoniae* with Phages

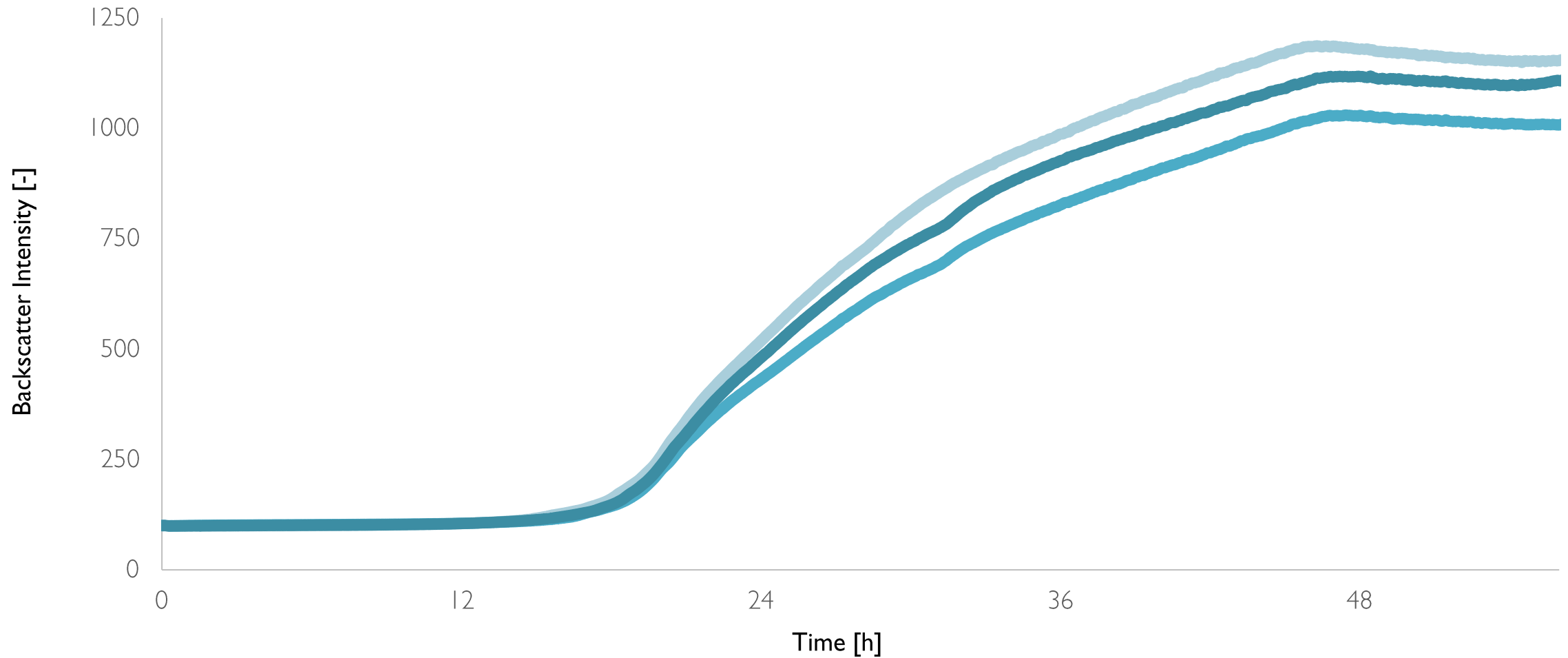


*Klebsiella pneumoniae*, 50 ml LB Medium, 250 ml Shake Flask, 37 °C, 150 rpm



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

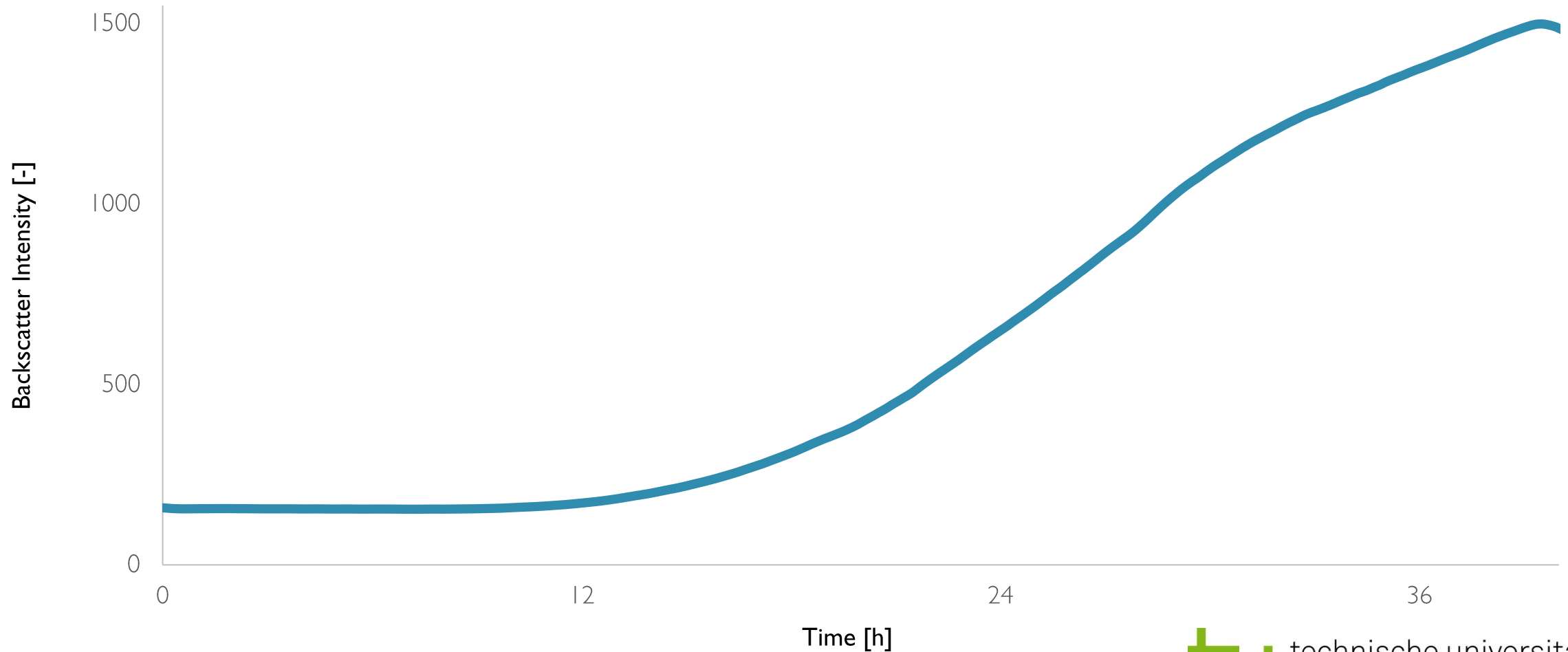
CGQ Measurement: *Aspergillus niger* Triplicates



*Aspergillus niger*, 50 ml LB Medium, 250 ml Shake Flasks, 25 °C. 250 rpm

The CGQ is capable of precisely monitoring *Streptomyces acidiscabies* cultures in shake flasks.

CGQ Measurements: *Streptomyces acidiscabies*



*Streptomyces acidiscabies*, 50 ml GYMS Medium, 250 ml Shake Flask, 30 °C, 160 rpm

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

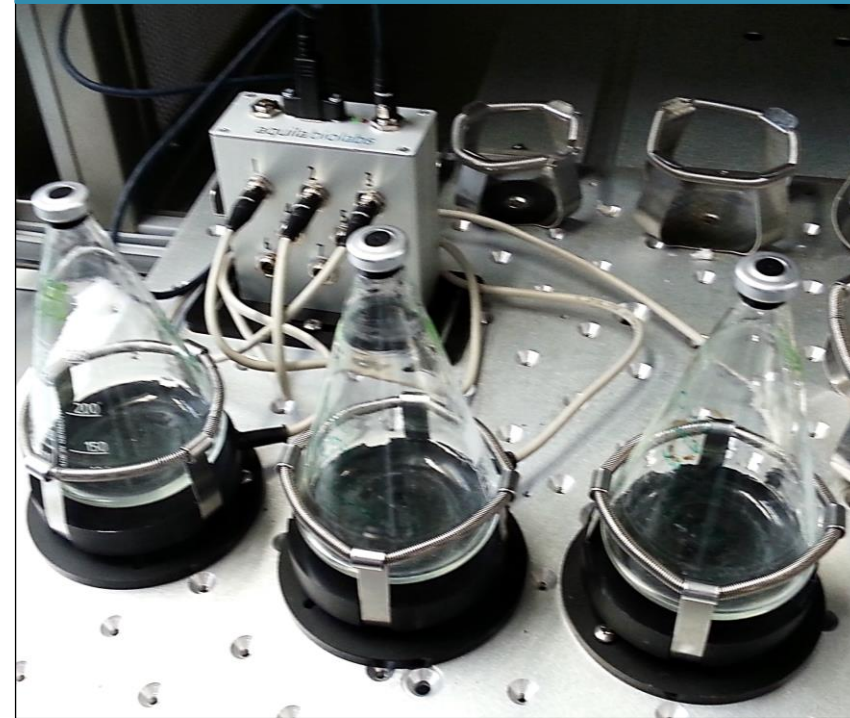
### CGQ for Anaerobic Cultivation Vessels

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CGQ with Serum Bottles

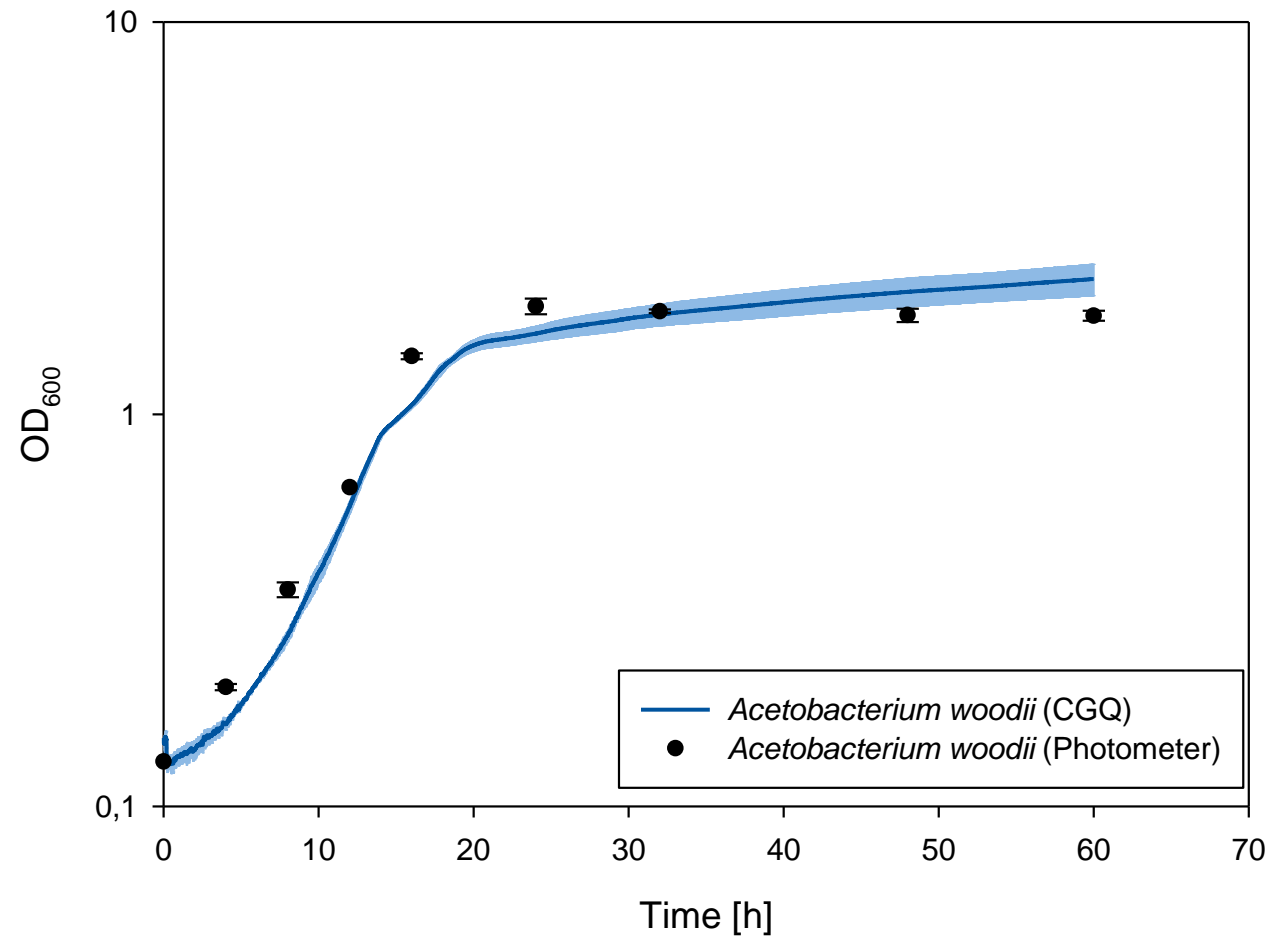


CGQ with Anaerobic Shake Flasks



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

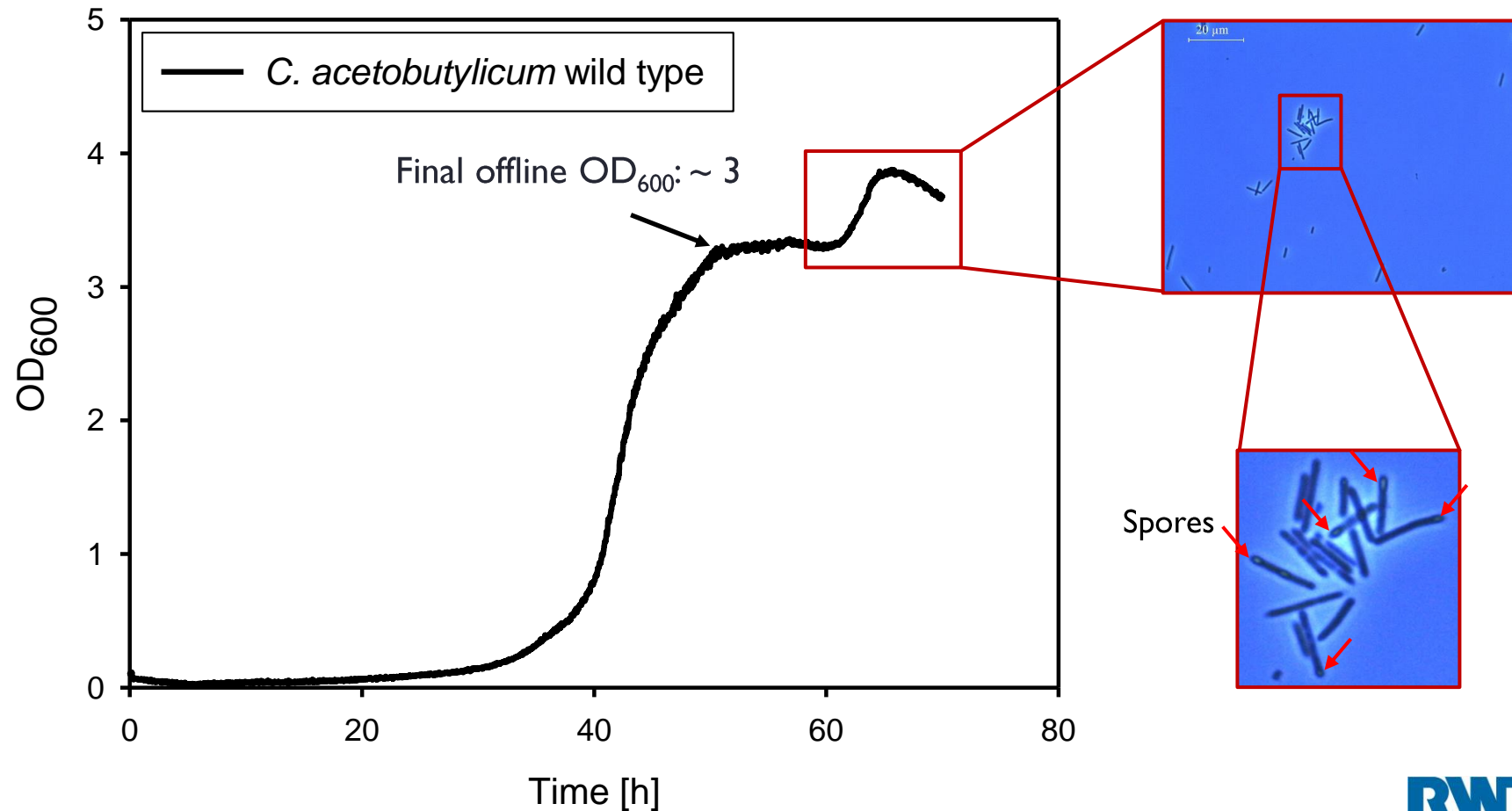
### CGQ & OD<sub>600</sub> Measurements: *Acetobacterium woodii* Triplicates



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

The CGQ allows for  $OD_{600}$  monitoring of anaerobic *Clostridium acetobutylicum* cultures and real time detection of spore formation.

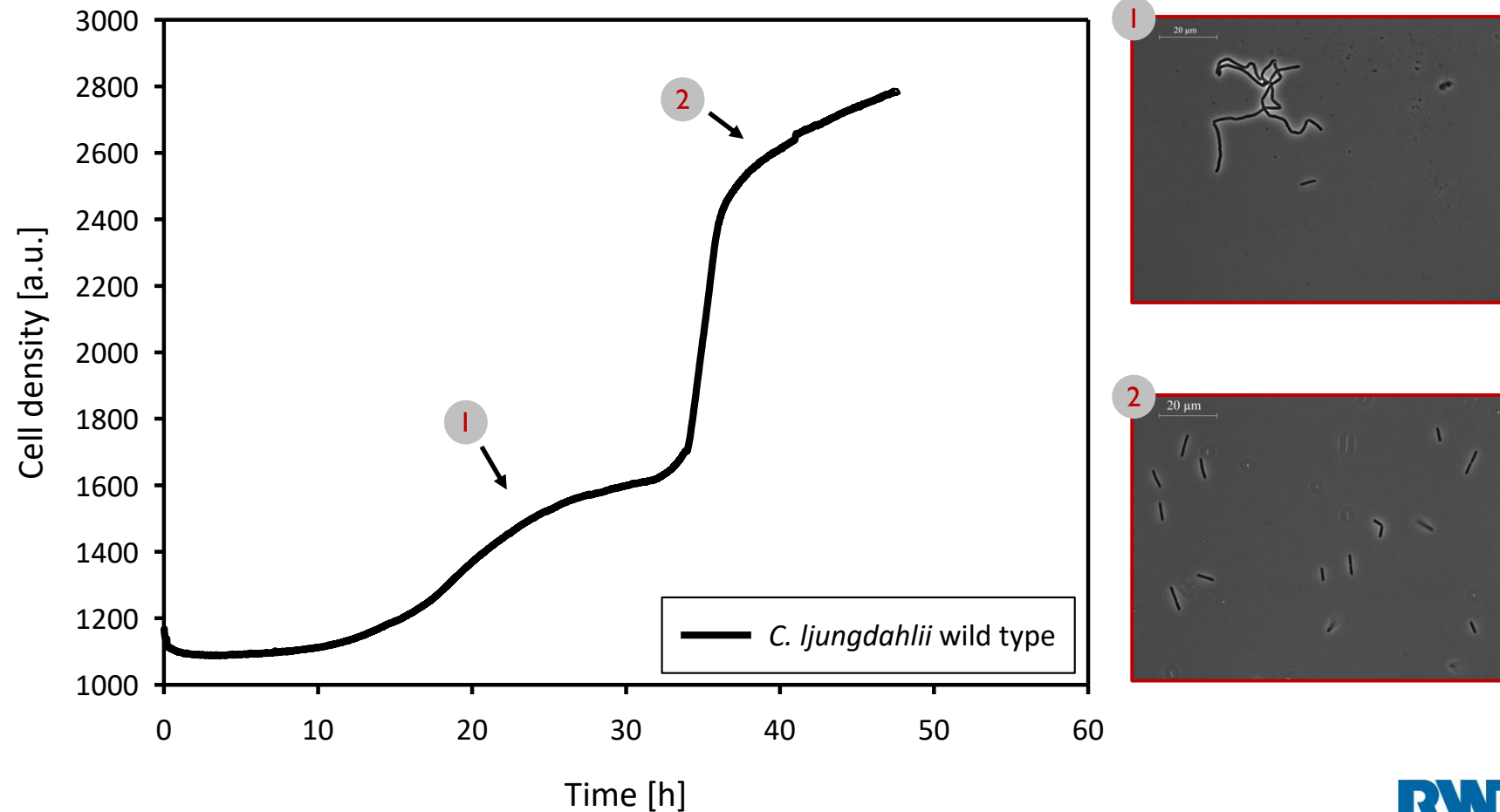
### CGQ Measurement & Microscopic Images: *Clostridium acetobutylicum*



*Clostridium acetobutylicum*, 50 ml MSM (+ MES), 100 ml Serum Bottle, 37 °C, 250 rpm

The CGQ allows for biomass monitoring of anaerobic *Clostridium ljungdahlii* cultures and detection of cell agglomeration.

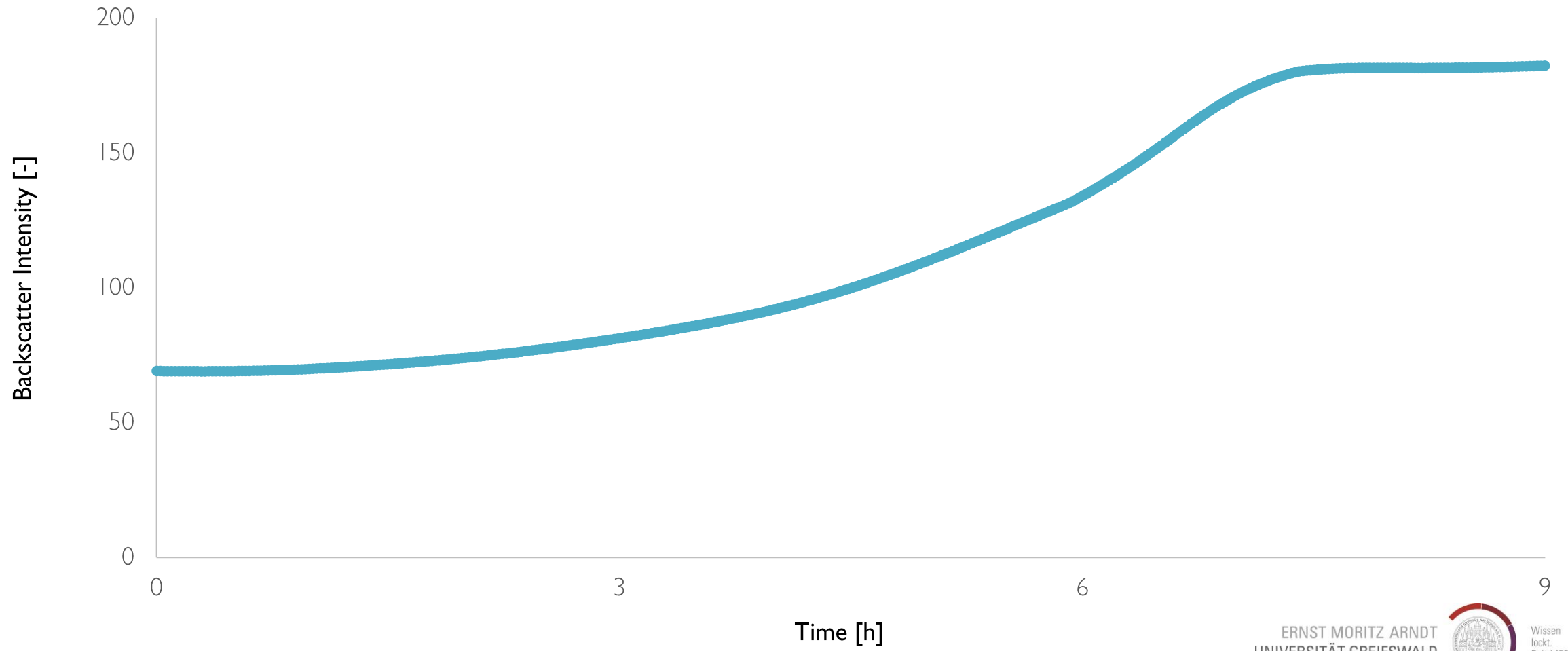
### CGQ Measurement & Microscopic Images: *Clostridium ljungdahlii*



*Clostridium ljungdahlii*, 100 ml RCM (+ Fructose), 200 ml Serum Bottle, 37 °C, 250 rpm

The CGQ is capable of precisely monitoring *Clostridium difficile* cultures in anaerobic shake flasks.

CGQ Measurements: *Clostridium difficile*



*Clostridium difficile*, 25 ml BHI Medium, 250 ml Sealed Shake Flasks, 37 °C, 180 rpm