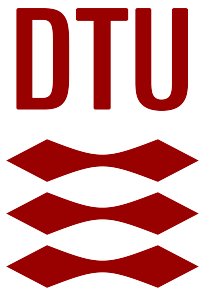


Monitoring fermentation processes combining ATR-MIR spectroscopy and kinetic models



Pau Cabaneros López

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Helena Junicke, Miguel M. Iglesias and Krist V. Gernaey

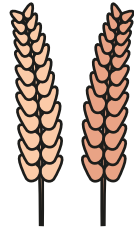
DSK 2020, flash talk

PROSYS, Department of Chemical and Biochemical Engineering
Technical University of Denmark



INTRODUCTION

CELLULOSIC
ETHANOL



STRAW



PRETREATMENT



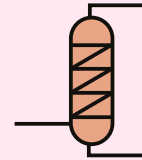
ENZYMATIC
HYDROLYSIS



FERMENTATION



DOWNSTREAM
RECOVERY



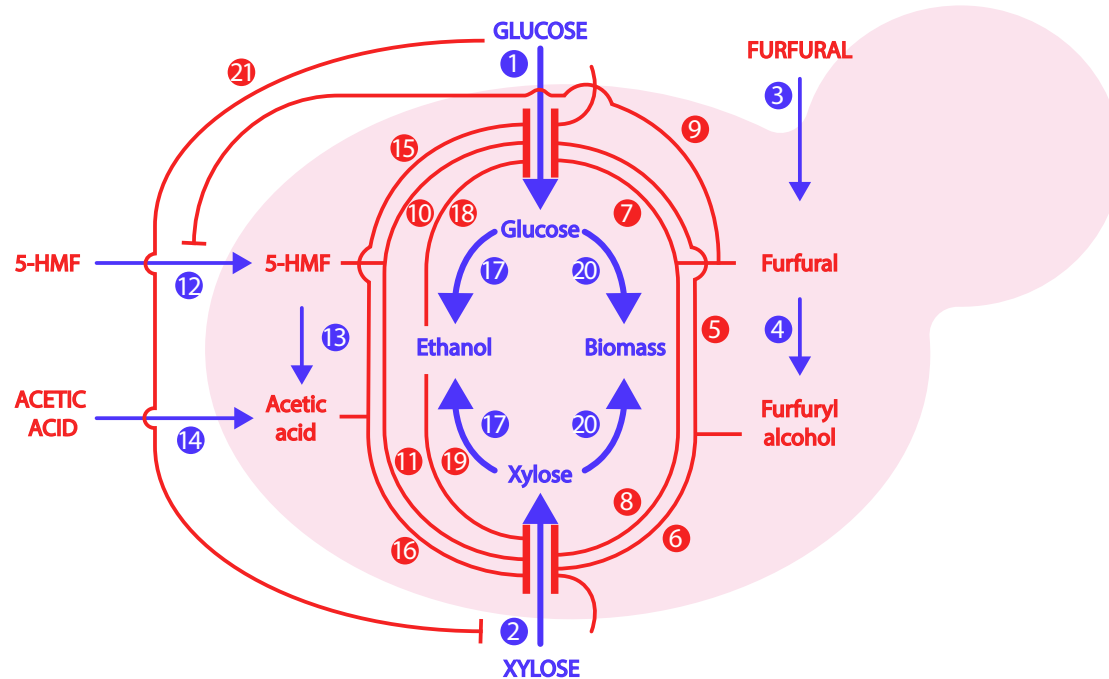
Operational challenges

High substrate variability

- When to stop the fermentation?
- What is the max ethanol concentration?

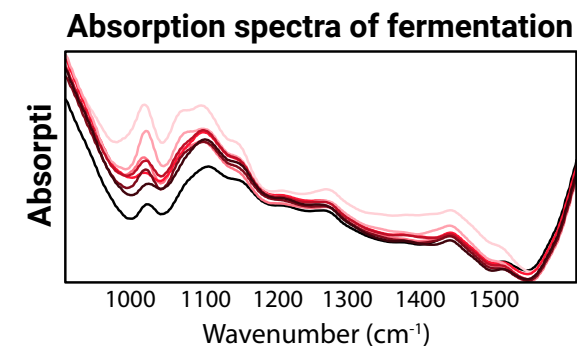
METHODS (I): modelling methods

Kinetic model



Monitoring key state variables

ATR-MIR + chemometrics



PLS

[Glucose]
[Xylose]
[Ethanol]

Advantages

- Only use the initial conditions to forecast the evolution of the fermentation.

Disadvantages

- Do not account for process deviations.

Advantages

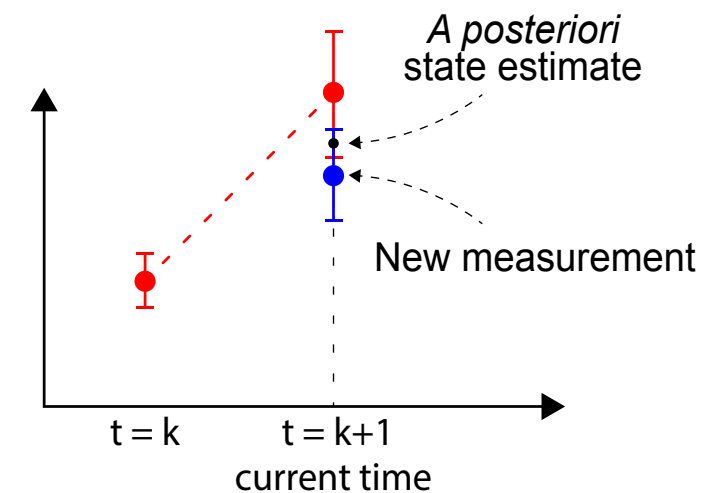
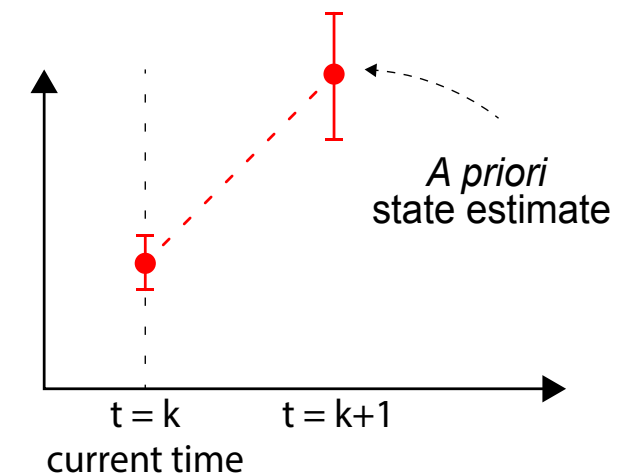
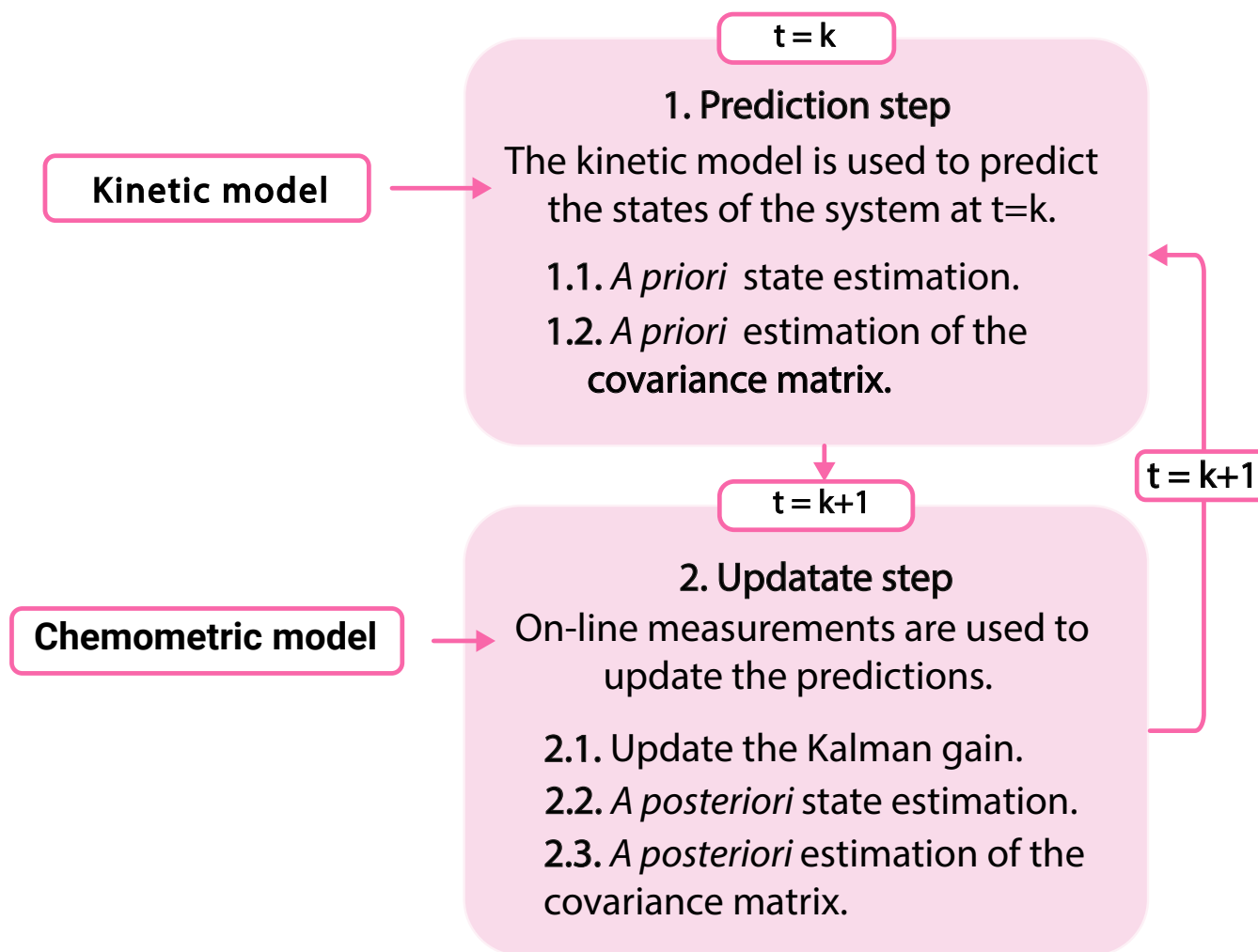
- *Real-time* information about the progress of the fermentation.

Disadvantages

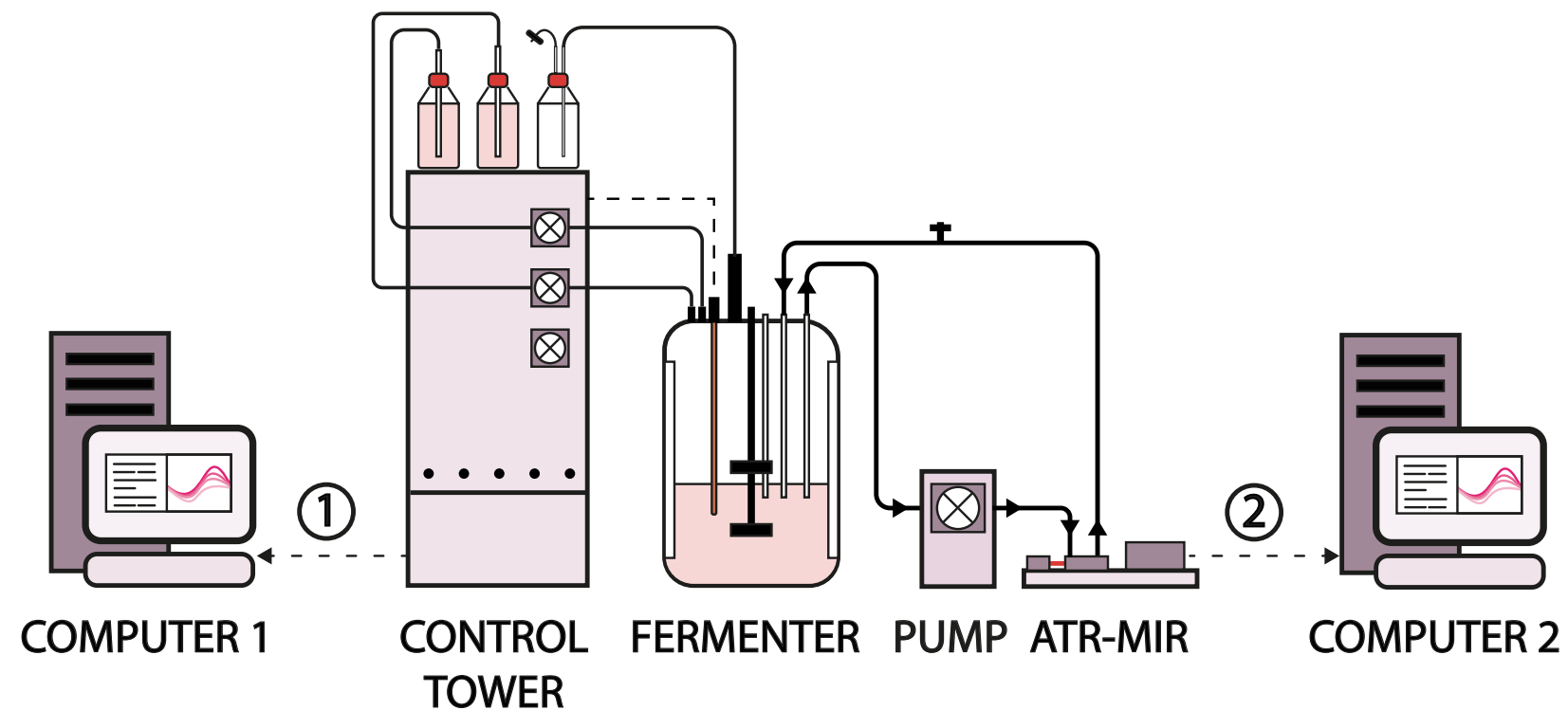
- Cannot forecast the progress of the fermentation process

METHODS (II): the Kalman filter

A CD-EKF is an extension of the Kalman filter to non-linear continuous systems with discrete measurements that allow ‘fusing’ the predictions made by a kinetic model with new measurements.



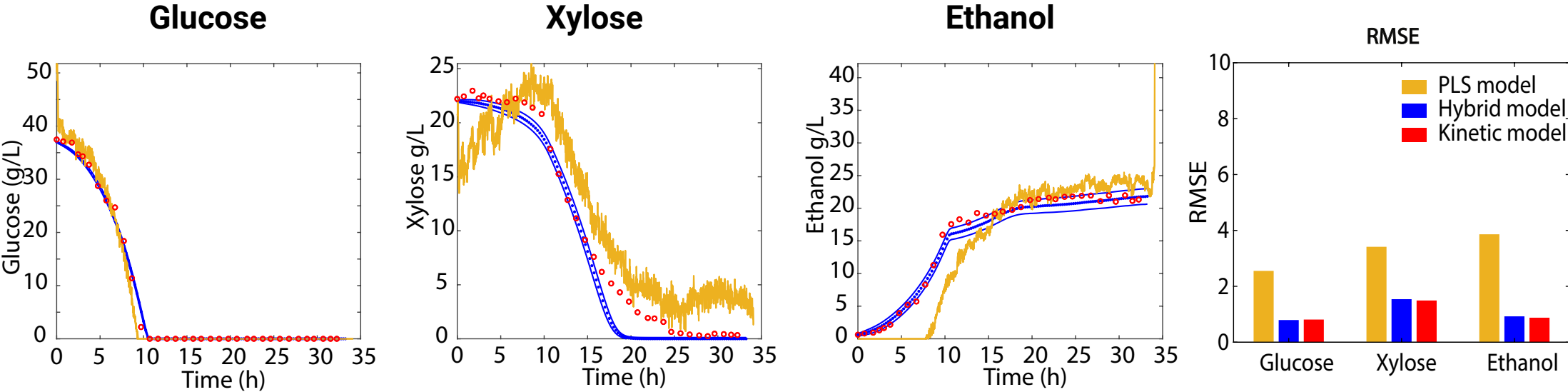
METHODS (III): experimental validation



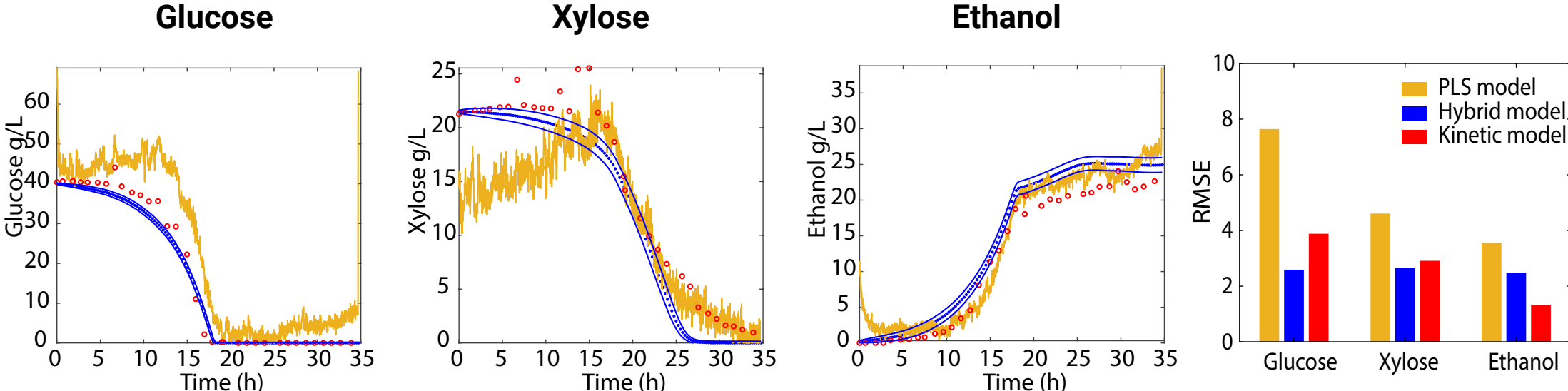
- Validation was done in lignocellulosic batch fermentations.
- The fermentation media was analysed every minute using a recirculation loop.

RESULTS

Fermentation 1

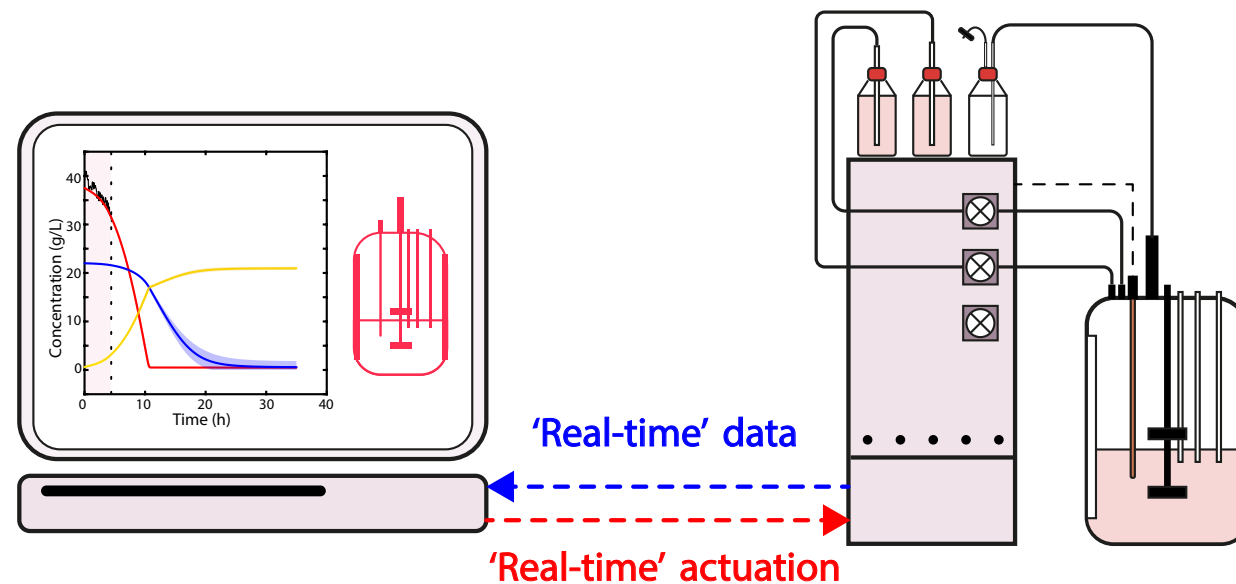


Fermentation 2



CONCLUSIONS

The **continuous discrete extended Kalman filter** has the advantage that it accounts for process deviations and measurement noise, making it more convenient to monitor processes with where measurements are noisy.



More details can be found at:

Cabaneros Lopez, Pau, et al. **“Transforming Data to Information: A Parallel Hybrid Model for Real-Time State Estimation in Lignocellulosic Ethanol Fermentation.”** Biotechnology and Bioengineering, John Wiley and Sons Inc, 2020, doi:10.1002/bit.27586.

PROJECT PARTNERS

