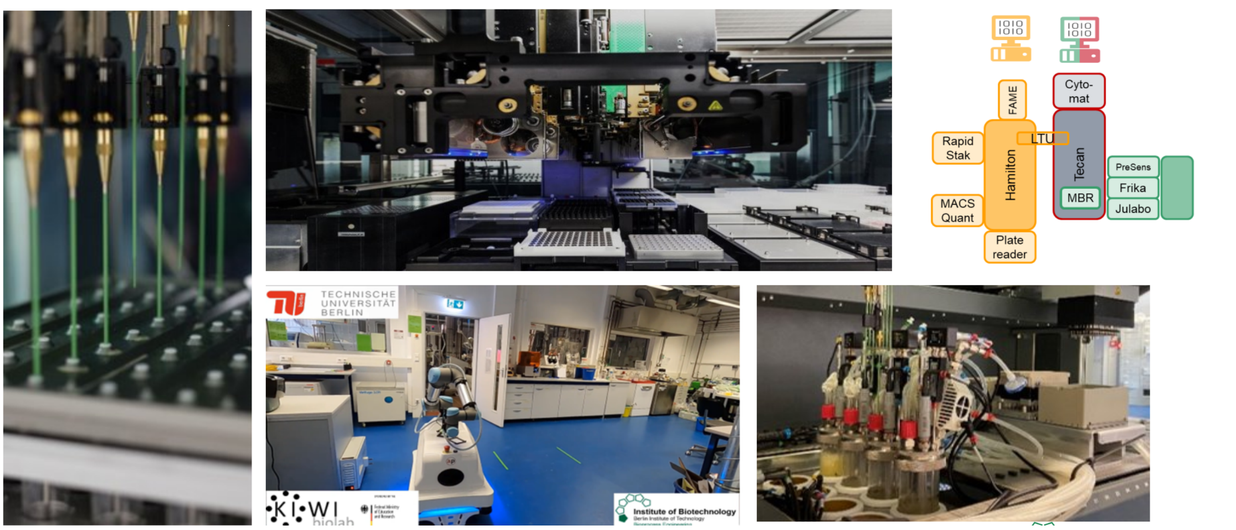
Seminario INGAR – **Jueves 09 de Marzo 2023, 10:30 hs.**

# The KIWI-biolab: automating bioprocess development




**Abstract -** The KIWI-biolab is leading research in the integration of Bioprocess Engineering, Robotics and Automation, and Machine Learning applied to Autonomous Bioprocess Development. Our main goal is to build the data management tools, mathematical models, computational algorithms, and robotic laboratory tools necessary to create a fully autonomous cognitive digital bioprocess development platform.

The rise of computer power and the progress in statistical modeling have set the path for incredible advances in Machine Learning. Computers can learn statistical models from observed data that generalize well and often allow to solve prediction and control problems better than humans. At the same time the amount of research data is ever increasing and its quality is improving due to initiatives on national and international levels to make research data findable and reusable (*FAIR principles*). Nevertheless, the biggest hurdles for autonomous development of bioprocesses are still to be tackled. Efficient data management tools, ML solutions tailored to the characteristics of bioprocesses (dynamics, high complexity, nonlinearity of the system, etc.), process control strategies that exploit parallel cultivations in High Throughput Facilities, and Active Learning algorithms that plan and operate optimal experiments.

Tackling these issues led to the first ever robotic parallel cultivations operated by an optimal operation strategy online [1]. Eight fed-batch processes were operated in parallel, gathering the data, recursively fitting a macro-kinetic model, and re-optimizing the experimental plan. To further prove our point and accelerate bioprocess development, have developed model-based methods to enable scale-down experiments in parallel mini-bioreactors [2] generating in one week the same amount of information that is typically obtained in six months. Advanced strain screening through online phenotyping and operation of parallel mini-bioreactors was achieved for the first in fully automated experiments [3]. Furthermore, nonlinear Model Predictive Control (nMPC) tools have also been developed for such highly nonlinear, stiff and uncertain systems as are *E. coli* cultivations in bolus fed-batch operation [4]. These solutions are maturing to the extent that not only academia but also industry is convinced of the added value that digitalization, data science, and machine learning have in bioprocess development and biopharma [5].

[1] Online optimal experimental re-design in robotic parallel fed-batch cultivation facilities for validation of macro-kinetic growth models
https://doi.org/10.1002/elsc.201200021

[2] A model‐based framework for parallel scale‐down fed‐batch cultivations in mini‐bioreactors for accelerated phenotyping
https://doi.org/10.1002/jctb.5798
[3] Automated Conditional Screening of Multiple Escherichia coli Strains in Parallel Adaptive Fed-Batch Cultivations
https://doi.org/10.3390/bioengineering7040145
[4] High-throughput screening of optimal process conditions using model predictive control
https://doi.org/10.22541/au.164600498.85996662/v2
[5] Bioprocessing in the Digital Age: The Role of Process
https://doi.org/10.1002/biot.201900172