ESR Positions

15 PhD Positions for Early Stage Researchers

Marie Skłodowska-Curie Innovative Training Network "DigitAlgaesation"

ESR1

Assessment of light dynamics on growth performance and definition of model-based protocol for algae selection and genetic manipulation

ESR2

Experimental and numerical investigation of culture systems involving complementary species for N2 fixation and extended solar radiation absorption

ESR3

Development and experimental assessment of a modelling approach for nutrient-light interactions description and optimization

ESR4

Development and analysis of a digital twin for monitoring, control and optimisation applications in microalgae

ESR5

Advanced techniques for model-based experiment design under uncertainty

ESR6

Development of a continuous microphotobioreactor for rapid model identification

ESR7

Microalgal population dynamics related to changes of environmental conditions

ESR8

Development of an online monitoring system of culture fitness and stress-induced intracellular metabolite accumulation in microalgae

ESR9

Sensor technology fusion for on-line monitoring and control

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Data mining approaches for monitoring and decision support of PBR processes

ESR11

Development of a deep-learning platform for process monitoring and optimization

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Microalgae high rate production by optimizing biofilm-based system

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Modelling and control of the photoacclimation response in an industrial environment

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Modelling and control of microalgae bacteria consortia for wastewater treatment

ESR15

Robust control of microalgae processes accounting for future meteorology

digitalgae
THE DIGITALGAESATION PROJECT

digitalgaesation.eu

ESR1

Assessment of light dynamics on growth performance and definition of model-based protocol for algae selection and genetic manipulation

Description:

Objectives: Biological assessment of the effects of light dynamics on microalgae growth. Experimental quantification of biological response. Identification of key biological parameters suitable for manipulation. Model-based quantification of potential benefits a given mutation on microalgae productivity. Prioritisation of potential targets for genetic manipulation (e.g. by deactivating heat dissipation boost performance in conditions of low illumination).
Expected results: Qualitative description and experimental quantification of light-growth interactions in a dynamic environment. Identification of biological parameters suitable for genetic intervention. Definition and demonstration of a model-based protocol for genetic intervention. Identification of targets for operation/control strategies to boost productivity by exploitation of light dynamics.

Hosting Institution:
University of Padova (Italy)

PhD Enrolment:
University of Padova (Italy)

Supervisors:
Prof. Tomas Morosinotto

Required skills:
Basic understanding of photosynthesis, Experience in molecular biology, Microbiology or biochemistry
Team working, creativity, written communication, independent working skills

ESR2

Experimental and computational investigation of cyanobacteria cultures using far-red/near-IR light for oxygenic photosynthesis and N2 fixation

Description:

Background: Some cyanobacteria are capable of growth using near-infra-red light (~750nm). This occurs when they are shaded from visible light by for example other photosynthetic species. In these conditions, around 20 genes are activated, including those that produce variant forms of Photosystem I and Photosystem II, which maintain 90% of chlorophyll-a but have 10% of long-wavelength chlorophyll-f. We showed evidence that the low energy chlorophyll-f acts as the primary electron donor in both photosystems (Nürnberg et al., Science 360:1210–1213). This surprising result opened-up several new avenues of research.

Objectives: A primary objective of the project will be on the measurement of photosynthetic parameters and N2-fixation in far-red chlorophyll f-containing strains of cyanobacteria. This experimental investigation of the conversion between visible-light (chlorophyll-a) growth and far-red-light (chlorophyll f) growth will focus on wavelength dependent photo-triggers, visible/far-red light ratios and intensities. Another main objective will be on the development of mathematical models capable of describing the dynamic transition to/from far-red light and sustained growth thereof. This activity will include the model calibration using the collected data, with particular emphasis on capturing i) light-limited growth for particular wavelengths, and ii) nitrogen fixation/nitrogen-limited growth.

Expected results: The modelling is expected to provide functional insights that can be tested experimentally in an iterative process that will provide: i) understanding of long wavelength oxygenic photosynthesis; ii) new insights into energy and nitrogen balances; iii) quantification of interaction between nitrogen stress, light, and growth dynamics; iv) improved culture conditions for long-wavelength species; and v) a model providing insights for improved biomass production and ultimately for photobioreactor design that will take advantage of the extended solar spectrum in the far-red/near IR.

Hosting Institution:
Imperial College London (United Kingdom)

PhD Enrolment:
Imperial College London (United Kingdom)

Supervisors:
Prof. Bill Rutherford, Prof. Benoit Chachuat, Dr Andrea Fantuzzi, Dr Stefania Viola

Required skills:
Biochemistry; Microbiology; Biophysics; Spectroscopy

Other desirable skills:
Mathematical modelling; Numerical simulation

ESR3

Development and experimental assessment of a modelling approach for nutrient-light interactions description and optimization

Description:

Objectives: The following objectives will be pursued: i) to elucidate interactions between light, nutrients in respect to microalgae growth via experimental investigations; ii) to formulate the interdependencies in growth kinetics; iii) to formulate usable model to describe these growth interdependencies; iv) to validate the model; v) assessment of wireless illumination technology for optimal low-energy intensity control.
Expected results: It is expected to establish the interdependencies and formulate a validated model describing algae growth at various light conditions. The model will be able to predict growth at various light conditions both as various light cycles, but also light intensities. The outcomes will serve as key
input information to the metabolic flux model developed by ESR4.

Hosting Institution:
Technical University of Denmark (Denmark)

PhD Enrolment:
Technical University of Denmark (Denmark)

Supervisors:
Prof. Irini Angelidaki

Required skills:
Bioprocess design, Microalgae cultivation, Modelling

ESR4

Development and analysis of a digital twin for monitoring, control and optimisation applications in microalgae

Description:

Objectives: Developing a metabolic model dealing with light variations. Integration of state-of-the-art dynamical photosynthesis models and metabolic flux modelling approaches (DRUM framework); numerical investigation of the dynamics of nitrogen and carbon storage under variable light (e.g. diurnal cycle, but also rapid light change due to hydrodynamics) using dynamic flux balance analysis; derivation of reduced models for on-line monitoring and control applications; interaction with ESR11 to integrate MGM with deep learning techniques.
Expected results: Generic “microalgae growth model” (MGM) to become the new standard for monitoring, control and optimisation applications in microalgae; validation of MGM for single and multi-layered cultivation systems; improved understanding of carbon-storage strategies under light- and nitrogen-limited conditions.

Hosting Institution:
INRIA (France)

PhD Enrolment:
INRIA (France)

Supervisors:
Prof. Olivier Bernard, Prof. Benoit Chachuat

Required skills:
Applied mathematics, Metabolism, Metabolic modelling, Optimisation

ESR5

Advanced techniques for model-based experiment design under uncertainty

Description:

Objectives: Develop new techniques for designing experiments using first-principles models, with particular emphasis on (a) experiments leading to improved accuracy of both model parameters and specified key performance indicators; (b) experiments for model discrimination; (c) effective handling
of model uncertainty in the context of model-based experiment design. Implement these techniques within the company process modelling environment.
Expected results: Prototype implementations of advanced model-based experiment design techniques within process simulator gPROMS; definition of a methodology for design of experiments under uncertainty; definition of a protocol for rapid discrimination and identification of models; application of
model-based experiment techniques to the microalgae growth model structure.

Hosting Institution:
Process Systems Enterprise (United Kingdom)

PhD Enrolment:
Imperial College London (United Kingdom)

Supervisors:
Prof. Costas Pantelides, Prof. Benoit Chachuat

Required skills:
Mathematical modelling, Numerical simulation, Optimisation

ESR6

Development of a continuous microphotobioreactor for rapid model identification

Description:

Objectives: Develop a microphotobioreactor capable of: i) generation of multiple concentration gradients, ii) support of long-term culture of algae cells iii) setting different temperature levels and complex light dynamics; iv) high-throughput studies with large numbers of replicates, v) compatibility with on-line imaging and standard analytics, vi) capability to apply fast dynamic changes of environmental signals.
Expected results: Prototype design of a microfluidic device capable of providing stable experimental conditions in a variety of conditions; validation of monitoring technology for microdevices; possibility to use the device for advanced design of experiments; measurements of biological response in varying conditions; definition of suitable control strategies to maximise growth/metabolic response.

Hosting Institution:
University of Padova (Italy)

PhD Enrolment:
University of Padova (Italy)

Supervisors:
Prof. Fabrizio Bezzo, Dr. Eleonora Sforza

Required skills:
Expertise in bioprocess engineering or industrial biotechnology.

Desirable skills:
Lab cultivation of microalgae, Microfluidics, Data analytics, Mathematical modelling.

ESR7

Microalgal population dynamics related to changes of environmental conditions

Description:

Objectives: The task of ESR7 is to study population dynamics in algae-based bioprocesses as a function of abiotic factors (nutrients, light). In addition to the population dynamics of pure cultures, the dynamics in mixed cultures is also of interest, since the simultaneous cultivation of several species can lead to improved stability of the bioprocess. The information on cellular and population response should yield a population model description which is able to predict outcomes of bioprocesses for pure and mixed cultures at dynamic process conditions.

Expected results: Understanding of microalgae population dynamics at fluctuating environmental conditions; development of a population model incorporating sub-population dynamics; incorporation of MGM into population models; assessment of flow cytometry for monitoring population dynamics (viability, productivity, cell division, etc).

Hosting Institution:
Technical University of Dresden (Germany)

PhD Enrolment:
Technical University of Dresden (Germany)

Supervisors:
Prof. Prof. Thomas Walther, Dr. Felix Krujatz

Required skills:
Bioprocess Engineering, Bioprocess modelling (Programming skills), Knowledge in single cell analytics are favorable (flow cytometry) but not essential

ESR8

Development of an online monitoring system of culture fitness and stress-induced intracellular metabolite accumulation in microalgae

Description:

Objectives: Development of an online optical sensor; development of an online culture colour measurement sensor (hardware, software); development of a software sensor using inputs from absorbance, colour, fluorescence, pO2 and other sensors for the microalgae culture fitness estimation;
development of sensors for the estimation of accumulation of selected intracellular metabolites as lipids and/or pigments in selected microalgae strains.
Expected results: Development of a novel online sensor system usable for rapid estimation of the microalgae culture physiological state or fitness and its biological parameters (concentration of intracellular metabolites); technology for integration of optical hardware sensors, classical process sensors and advanced real-time data processing.

Hosting Institution:
"G. W. Leibniz" University of Hannover (Germany)

PhD Enrolment:
"G. W. Leibniz" University of Hannover (Germany)

Supervisors:
Dr. Ivo Havlik, Prof. Thomas Scheper, Prof. Sascha Beutel

Required skills:
Knowledge of optical online sensors and sensor development inclusive data acquisition and processing, mathematical modelling of bioprocesses, data analysis, neural networks, deep network learning, fuzzy logic, clustering, image processing, and synthesis of software sensors
Programming skills (e.g. MATLAB, Python or equivalent)
Expertise in bioprocess engineering, especially cultivation processes of microorganisms from a shake flask to a controlled bioreactor

ESR9

Sensor technology fusion with advanced photobioreactors for on-line monitoring and control

Description:

Objectives: Integration of state-of-the-art sensor technology in a lab-scale photobioreactor: integration of on-line monitoring and mass balancing based on the measurement of CO2 consumption, O2 production, biomass production and nitrogen consumption; inclusion of PAM fluorescence and VIS absorption spectroscopy. Calibration, and/or validation, of MGM approach with the photobioreactor developed in order to realize a generic model description of microalgal production processes.

Expected results: Methods for combining monitoring systems with (mechanistic) algal growth models to get better insight in the process, to allow for more efficient control; demonstration of the potential of on-line mass balancing for process monitoring and control for specific production processes. An experimental chassis for high quality data generation which can be further employed for machine-learning based model approaches.

Hosting Institution:
Wageningen University (The Netherlands)

PhD Enrolment:
Wageningen University (The Netherlands)

Supervisors:
Dr. Marcel Janssen, Prof. dr. Maria J. Barbosa

Required skills:
Expertise in bioprocess engineering, i.e. cultivation of microorganisms in controlled bioreactors and hands-on attitude
Expertise in metabolic modelling (e.g. flux balance analysis)
Expertise in, or affinity with, photosynthetic processes
Programming skills (e.g. MATLAB, Python or equivalent)

ESR10

Data mining approaches for monitoring and decision support of photobioreactor processes

Description:

Objectives: Key objectives will be: i) development of a platform for integrative data mining of heterogeneous monitoring data for the prediction of process outcomes in microalgae cultivation; ii) new methods for predictive analysis of the response to growth condition permutations; iii) development of artificial intelligence based predictive models for monitoring and optimization of microalgae growth conditions.
Expected results: Platform for data collection and integration; availability of predictive models for unsupervised anomaly detection; methods for analysing the data workflow for pattern discovery of permutation responses in growth conditions; algorithms for automatic identification of optimal growth conditions, and experimental validation of automatic growth condition recommendations.

Hosting Institution:
Proviron (Hemiksem (Antwerp), Belgium)

PhD Enrolment:
University of Antwerp (Belgium)

Supervisors:
Dr. Luc Roef, Prof. Kris Laukens

Required skills:

We are seeking a self-motivated, independent and hands-on scientist with a Master degree in computer science, (bio-)engineering, bioinformatics, statistics or equivalent.
Expertise in or strong affinity with sensor / signal data processing, data mining, machine learning
Strong programming skills (preferably JavaScript, Python, C and C++, R)
Affinity with biological process engineering i.c. cultivation of (photosynthetic) microalgae (or microorganisms) in photobioreactors or keen to learn on this subject earns bonus points
The candidate is expected to be a highly collaborative team-player with a critical problem-solving mindset, eager to pass on skills and knowledge to other team members that thrives in a company environment.
Excellent knowledge of English and good communication skills are a must, knowledge of Dutch is welcome.

ESR11

Development of a deep-learning platform for process monitoring and optimization

Description:

Objectives: Development of deep learning algorithms combining process models and neural networks for a rapid indirect measurements of biological variables of interest; integration (data fusion) of sensor systems in different scales of industrial tubing PBRs (scale-effect); development of tools for automatic operation based on biological specific response (strain-dependent) and cultivation features (geometry-dependent).
Expected results: development of a monitoring/optimisation platform based on deep-learning techniques; algorithms for data fusion integrating sensor data and microalgae growth model predictions; methodology for automatic corrections of proposed algorithm based on specific biological features and equipment design specifications; assessment in a real-case industrial system.

Hosting Institution:
MINT Engineering (Germany)

PhD Enrolment:
Technical University of Dresden (Germany)

Supervisors:
Mr. Gunnar Mühlstädt, Prof. Thomas Walther

Required skills:
Neural network, data analytics, bioprocess analysis, automatic control

ESR12

Microalgae high rate production by optimizing biofilm-based system

Description:

Objectives: Development of a model of biofilm growth dynamics and process productivity based on the generic MGM model; design of a control law aiming at maintaining optimal operating conditions that maximizes the process productivity; the control law must be robust with respect to model uncertainties, estimation errors and disturbances (e.g. light variation); assessment of the benefits of a biofilm-based process over a suspended culture.
Expected results: Model of biofilm growth and composition; definition of a calibration procedure to identify model parameters; assessment of advanced sensors to on-line track the biomass and the main physiological variables; definition of a validated control strategy in order to track optimal conditions
that maximize process productivity.

Hosting Institution:
CentraleSupelec (France)

PhD Enrolment:
CentraleSupelec (France)

Supervisors:
Prof. Filipa Lopes, Prof. Sihem Tebbani

Required skills:
Modelling, Automatic control, Bioprocess design, Microalgae cultivation

ESR13

Modelling and control of the photoacclimation response in an industrial environment

Description:

Objectives: Assessing photoacclimation dynamics and interactions with other photosynthetic processes; measurement and modelling in an industrial environment; assessment of photoacclimation and adaptation dynamics of selected strains and mutants; interactions between temperature and light dynamics; definition of operation strategies for optimising the response of different microalgae at varying light conditions

Expected results: Quantification of photoacclimation dynamics; modelling of interactions between photoacclimation and other light dynamics (e.g., mixing and day-night cycles); assessment of growth dynamics and adaption of genetically modified strains; definition of a control strategy to optimize light conversion efficiency.

Hosting Institution:
TMCI Padovan (Italy)

PhD Enrolment:
University of Padova (Italy)

Supervisors:
Dr. Diana Simionato, Prof. Tomas Morosinotto, Prof. Fabrizio Bezzo

Required skills:
Automatic control, bioprocess design and optimisation, microalgae cultivation

ESR14

Modelling and control of microalgae bacteria consortia for wastewater treatment

Description:

Objectives: Experimental assessment of conditions affecting growth and activity of microalgae-bacteria consortia; identification of minimum measurements required to monitor the performance of wastewater treatment; development of a model-based approach for control and optimisation of wastewater treatment in large scale reactors using microalgae
Expected results: Definition of a model-based monitoring system for wastewater treatment using microalgae-bacteria consortia; definition of a protocol for model identification; control strategy to boost performance in microalgae cultivation systems using wastewater; integration of tools and software into a supervision platform.

Hosting Institution:
University of Almeria (Spain)

PhD Enrolment:
University of Almeria (Spain)

Supervisors:
Prof. Jose María Fernández-Sevilla, Prof. Francisco Gabriel Acién-Fernandez, Prof. Jose Luis Guzmán

Required skills:
Chemical Engineering or Control Engineering
Numerical programming, Matlab or other similar software usage.

ESR15

Robust control of microalgae processes accounting for future meteorology

Description:

Objectives: Develop a model of microalgae cultivation under a greenhouse. Set-up an automatic model calibration from pre-treated on-line data for model auto-adaptation; use future weather forecasts to optimize water and energy fluxes; from global optimization of large scale models, develop an advanced framework within a commercial technological platform own by INRIA; assess the potential of this approach with pilot raceways under a greenhouse; develop protocols allowing for real-time reconciliation of all sensor data resulting in real-time.

Expected results: A model predictive approach with auto-adaptation, which takes benefit of future meteorology to track both the culture density and the temperature along the day; implementation of the control strategy on a pilot plant with the ODIN software; benefits assessments in terms of productivity, water use, energy use and manpower requirement.

Hosting Institution:
INRIA (France)

PhD Enrolment:
INRIA (France)

Supervisors:
Prof. Olivier Bernard

Required skills:
Automatic control, Optimisation, MPC, radiative transfers, on-line control, programming with scientific software (Matlab or Python)