Jean-Baptiste Lugagne

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Education

2016 **PhD, Bioengineering**, U. Sorbonne Paris-Cité, France

Real-time control of a genetic toggle switch
Co-advised by Prof. Grégory Batt, Inria & Prof. Pascal Hersen, Cnrs.

2012 **M.S., Signal Processing Engineering**, Grenoble Institute of Technology, France

Stochastic simulation of enzymatic reactions under transcriptional feedback regulation
Co-advised by Prof. Guy-Bart V. Stan & Dr. Diego A. Oyarzún, Imperial College London.

2010 **B.S., Electrical Engineering**, Grenoble Institute of Technology, France

Research experience

2018-Present **Post-doctoral researcher**, Boston University, Boston, United States
Advisor: Prof. Mary J. Dunlop

- Published 9 journal papers, including 5 as first author and 3 as co-corresponding author.
- Established 3 new research avenues, resulting in the first demonstration of data-driven control of gene expression, the DeLTA microscopy analysis toolbox now widely used in the field, and an ongoing collaboration on Raman-based imaging of bioproduction in bacteria.
- Set up lab capabilities for microfluidics, automated microscopy, single-cell optogenetics, & machine learning.

2012-2017 **Graduate research assistant & Post-doctoral researcher**, Cnrs & Inria, Paris, France
Advisors: Prof. Pascal Hersen & Prof. Grégory Batt

- Published 4 journal papers, including 3 as first author and 1 as co-corresponding author.
- Led research projects on real-time feedback control of a multi-stable genetic toggle switch and on ML-based microscopy image analysis.
- Set up lab capabilities for bacterial synthetic biology and microfluidics.

2012 **Graduate research assistant**, Imperial College, London, UK
Advisors: Prof. Guy-Bart Stan & Dr. Diego Oyarzún

- Published 1 first-author conference paper and 1 journal paper.
- Led research project on genetic-metabolic feedback control and noise propagation.

Publications

†: co-corresponding author – ∗: co-first author

Lugagne, J.-B.†, Blassick, C. M., Dunlop, M. J.†(2024). Deep model predictive control of gene expression in thousands of single cells. *Nature Communications*. 10.1038/s41467-024-46361-1

Klumpe, H. E.*, **Lugagne, J.-B.***†, Khalil, A. S., Dunlop, M. J.†(2023). Deep neural networks for predicting single cell responses and probability landscapes. *ACS Synthetic Biology*. 10.1021/acssynbio.3c00203

Tague, N., Lin, H., **Lugagne, J.-B.**, O'Connor, O. M., Burman, D., Wong, W. W., Cheng, J.-X., Dunlop, M. J. (2023). Longitudinal single-cell imaging of engineered strains with stimulated Raman scattering to characterize heterogeneity in fatty acid production. *Advanced Science*. 10.1002/advs.202206519

Lugagne, J.-B., & Dunlop, M. J. (2022). Anticipating antibiotic resistance. *Science*. [Perspective] 10.1126/science.abn9969

Sampaio, N. M. V, Blassick, C. M., Andreani, V., **Lugagne, J.-B.**, & Dunlop, M. J. (2022). Dynamic gene expression and growth underlie cell-to-cell heterogeneity in Escherichia coli stress response. *PNAS*. 10.1073/pnas.2115032119

O'Connor, O. M., Alnahhas, R. N., **Lugagne, J.-B.**†, & Dunlop, M. J.†(2022). DeLTA 2.0: A deep learning pipeline for quantifying single-cell spatial and temporal dynamics. *PLOS Computational Biology*. 10.1371/journal.pcbi.1009797

Lin, H., Lee, H. J., Tague, N., **Lugagne, J.-B.**, Zong, C., Deng, F., Shin, J., Tian, L., Wong, W., Dunlop, M. J., & Cheng, J.-X. (2021). Microsecond fingerprint stimulated Raman spectroscopic imaging by ultrafast tuning and spatial-spectral learning. *Nature Communications*. 10.1038/s41467-021-23202-z

Lugagne, J.-B., Lin, H., & Dunlop, M. J. (2020). DeLTA: Automated cell segmentation, tracking, and lineage reconstruction using deep learning. *PLOS Computational Biology*. 10.1371/journal.pcbi.1007673

Lugagne, J.-B., & Dunlop, M. J. (2019). Cell-machine interfaces for characterizing gene regulatory network dynamics. *Current Opinion in Systems Biology*. 10.1016/j.coisb.2019.01.001

Lugagne, J.-B.†, Jain, S., Ivanovitch, P., Ben Meriem, Z., Vulin, C., Fracassi, C., Batt, G., & Hersen, P.†(2018). Identification of individual cells from z-stacks of bright-field microscopy images. *Scientific Reports*. 10.1038/s41598-018-29647-5

Lugagne, J.-B., Kirch, M., Köhler, A., Batt, G., & Hersen, P. (2017). Balancing a genetic toggle switch by real-time feedback control and periodic forcing. *Nature Communications*. 10.1038/s41467-017-01498-0

Lugagne, J.-B., Brackx, G., Seyrek, E., Berret, J.-F., Hersen, P., & Charron, G. (2017), Assembly and characterizations of bifunctional fluorescent and magnetic microneedles displaying length tunability over one decade, *Advanced Functional Materials*. 10.1002/adfm.201700362

Piffoux, M., Silva, A. K. A., **Lugagne, J.-B.**, Hersen, P., Wilhelm, C., & Gazeau, F. (2017). Extracellular vesicle production loaded with nanoparticles and drugs in a trade-off between loading, yield and purity: Towards a personalized drug delivery system. *Advanced Biosystems*. 10.1002/adbi.201700044

Oyarzún, D. A., **Lugagne, J.-B.**, & Stan, G. B. V. (2014). Noise propagation in synthetic gene circuits for metabolic control. *ACS Synthetic Biology*. 10.1021/sb400126a

Lugagne, J.-B., Oyarzún, D. A., & Stan, G. B. V. (2013). Stochastic simulation of enzymatic reactions under transcriptional feedback regulation. In *IEEE European Control Conference 2013 (ECC13)*. 10.23919/ECC.2013.6669756

Research presentations

Talks

Lugagne, J.-B. (2024). *Latsis Symposium on Smart Microscopy*, EPFL, Lausanne, Switzerland.

Lugagne, J.-B. (2024). *BWH Computational Pathology Seminars*, Harvard University, Boston, USA.

Lugagne, J.-B. (2024). University of Oxford, Oxford, United-Kingdom.

Lugagne, J.-B. (2024). Imperial College, London, United-Kingdom.

Lugagne, J.-B. (2024). Northeastern University, Boston, USA.

Lugagne, J.-B. (2023). University of Edinburgh, Edinburgh, United-Kingdom.

Lugagne, J.-B., Klumpe, H. E., Blassick, C. M., *&* Dunlop, M. J. (2023). *Physics of Living Systems seminars*, MIT, Boston, USA.

Lugagne, J.-B., Klumpe, H. E., Blassick, C. M., *&* Dunlop, M. J. (2023). *SwissUK Synbio*, Lausanne, Switzerland.

Lugagne, J.-B., *&* Dunlop, M. J. (2022). *Biocontrol seminars*, Online.

Lugagne, J.-B., *&* Dunlop, M. J. (2022). *Winter Q-Bio 2022*, Ko Olina, Hawaii, USA.

Lugagne, J.-B., *&* Dunlop, M. J. (2021). *BDC Spring Symposium*, Boston University, Boston, USA.

Lugagne, J.-B., *&* Dunlop, M. J. (2019). *BDC Symposium*, Boston University, Boston, USA.

Lugagne, J.-B. (2017). ETH Zürich, Zürich, Switzerland.

Lugagne, J.-B. (2017). University of Edinburgh, Edinburgh, United-Kingdom.

Lugagne, J.-B. (2017). University of Cambridge, Cambridge, United-Kingdom.

Lugagne, J.-B., Kirch, M., Köhler, A., Batt, G., *&* Hersen, P. (2015). *Design, Optimization and Control in Systems and Synthetic Biology*, Paris, France.

Lugagne, J.-B., Oyarzún, D. A., *&* Stan, G. B. V. (2013). *IEEE European Control Conference 2013 (ECC13)*, ETH Zürich, Switzerland.

Conference posters

Lugagne, J.-B., Tague, N., *&* Dunlop, M. J. (2019). *Q-Bio 2019*, San Francisco, California, USA.

Lugagne, J.-B., Tague, N., *&* Dunlop, M. J. (2019). *EBRC Retreat*, Boston, Massachusetts, USA.

Lugagne, J.-B., Kirch, M., Köhler, A., Batt, G., *&* Hersen, P. (2017). *International Workshop on Control Engineering and Synthetic Biology*, London, United-Kingdom.

Lugagne, J.-B., Kirch, M., Köhler, A., Batt, G., *&* Hersen, P. (2015). *Who Am I Colloquium*, Deauville, France.

Grant writing

National Science Foundation – grant `2032357` – $800k Awarded
"Single-cell feedback, optogenetics, and deep learning to control gene expression in bacteria"

- Came up with complete concept for grant *&* wrote entire draft of proposal.
- Worked with Dr. Dunlop on grantsmanship and refining project objectives.
- Responded to reviewer feedback.

Department of Energy – grant `DE-SC0019387` – $1.5M Awarded
"High-throughput chemical imaging for optimizing biofuel synthesis using synthetic biology"

- Wrote all of one project objective (out of three).
- Generated preliminary data demonstrating feasability of project goals.
- Worked with collaborators and project PIs to refine proposal ideas.

National Science Foundation – grant `2143289` – $600k Awarded
"Transitions: Deep Learning Models for Microbial Image Analysis and Time-Series Predictions"
&
National Institutes of Health – grant `R01AI102922` – $2M Awarded
"Cell-to-cell heterogeneity and the emergence of antibiotic resistance"

- Provided feedback and input to Dr. Dunlop.
- Generated preliminary data to demonstrate feasibility of both projects.

Teaching & mentoring experience

2023-2024 Produced and delivered lectures and activities as part of the STEM Pathways outreach programme at Boston University, for advanced high-school students.

2018-2024 Supervised 6 PhD rotation projects, on a range of topics including CRISPR-based genomic integration, deep learning-based image processing, or optogenetic growth control.

2018-2021 Produced and delivered lectures in BE404 Control Theory, Boston University, under-graduate and graduate level.

2019-2020 Produced and delivered lectures in BE403 Signal Processing, Boston University, under-graduate and graduate level.

2018-2020 Supervised 2 Senior design project teams, for the development of automated sample preparation devices, and for a cloud-computing based web interface for microscopy image analysis.

2014-2017 Supervised 2 Master's students projects on machine learning based image analysis of microscopy images.

2015-2016 Co-supervised a Master's student thesis on biological laboratory design and social interactions within a research group.

2013-2015 Supervised 2 Master's students theses on mathematical modelling of real-time control of a genetic toggle switch.

2012 Supervised International Genetically Engineered Machine competition (iGEM) Grenoble team, especially for mathematical modelling of gene expression.

Service

10+ years of scientific project management, as part of a team, a larger collaboration, or as main researcher, from conception to publication and follow-up studies.

Co-organizer of outreach events with Boston University's STEM Pathways, including a Hackathon on Biomedical Image Analysis.

Co-organizer of the Biocontrol seminars, a series of monthly online seminars featuring international speakers, and of the Biocontrol Workshop, an upcoming online international conference on biological control systems.

Collaboration on open-source and open data research projects and active support for the community, for example on a software for microscopy time-lapse analysis (DeLTA).

Member of the IEEE Technical Committee on Systems and Synthetic Biology and IFAC member.

Referee for journals and conferences in the field, including: L4DC, Science, Nature Computational Science, Nature Communications, PLOS Computational Biology, Journal of Mathematical Biology.