THOMAS LAVIGNE, PhD

Post-Doctoral Researcher | Biomechanics & Poromechanics

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PROFESSIONAL SUMMARY

Computational biomechanics researcher specializing in the poromechanical and multiscale modeling of soft biological tissues. Awarded a Dual Doctoral Degree (cotutelle Université du Luxembourg / ENSAM Paris) focused on developing a physics-based, hierarchical porous media framework to understand human skin micro-circulation and pressure ulcer aetiology. Recognized for bridging complex theoretical developments, *in vivo* experimental campaigns, and high-performance numerical implementation. Dedicated to Open Science and reproducibility, having developed open-source simulation tutorials and a Python package (FEniCSx). Described by the PhD defense jury as an exceptional scientist positioned to become a “reference in this emerging field."

EDUCATION

Co-tutelle PhD in Engineering Sciences (Biomechanics)
Sept. 2022 – July 2025

Legato Team (Univ. Luxembourg), IBHGC (ENSAM Paris, France), & I2M (Univ. Bordeaux, France)

- **Thesis:** *Biomechanical Response of Human Skin: A Hierarchical Porous Media Framework.*
- **Funding:** AFR-FNR Grant N°17013812
- **Directors:** Pr. Stéphane Bordas (Uni.lu), Dr. Pierre-Yves Rohan (ENSAM), Dr. Giuseppe Sciumè (I2M).
- **2025 Excellent Thesis Award** (University of Luxembourg) — Nominated for the **Tarrach Prize** and **Prix Bézier** (ENSAM). Applicant for the **FNR Outstanding PhD Thesis** Award.
- **Best Poster Award** (Ranked 2nd, PhD Day, Luxembourg 2024).

Pre-Doctoral Research Year (ENS International Mobility)
Sept. 2021 – Sept. 2022

Legato Team (Univ. Luxembourg) & École Normale Supérieure (ENS) Paris-Saclay

- One-year research fellowship focused on the surrogate modelling of breast tissue deformation using DVC and FEM.
- This successful placement laid the foundation for the subsequent co-tutelle PhD project.

Master of Science in Biomechanics (BME Paris Program)
2020 – 2021

École Nationale Supérieure des Arts et Métiers (ENSAM), Paris

- Graduated with high honours, ranking **4th out of 27** students.
- Specialized in computational biomechanics, soft tissue mechanics, and advanced finite element modelling.

Master 1 & Bachelor’s in Mechanical Engineering Sciences
2018 – 2020

École Normale Supérieure (ENS) Paris-Saclay

- **Master 1 (Mécanique et ingénierie de production - MIP):** Ranked **1st out of 18** students.
- **Bachelor’s Degree:** Received with high honours, ranking **12th out of 70** students.

Classes Préparatoires aux Grandes Écoles (PCSI/PSI*)
2016 – 2018

Lycée Hoche, Versailles

- Intensive two-year academic program in advanced mathematics, physics, and engineering sciences.
- Rigorous preparation for the highly competitive national entrance exams to the French *Grandes Écoles* (leading to admission at ENS Paris-Saclay).

FELLOWSHIPS & AWARDS

2025 **Excellent Thesis Award**, University of Luxembourg - among best 10% of doctoral theses of the year at the Faculty of Science, Technology and Medicine
2025 **PhD Graduation Talk**, University of Luxembourg - among 5 people chosen out of the PhD graduates to hold a pitch talk at the PhD graduation ceremony
2025 **Nominated**, Tarrach Prize — Les Amis de l'Université du Luxembourg
2025 **Proposed**, Prix Bézier — ENSAM
2025 **Applicant**, FNR Outstanding PhD Thesis Award
2024 **Best Poster Award** (2nd place), PhD Day, Luxembourg
2024 **Most Cited Paper Prize**, Journal of Strain Analysis (2020 paper on pantographic metamaterials)
2022 **AFR-FNR Doctoral Fellowship** N°17013812
2022 Contrat Doctoral Spécifique Normalien (**CDSN** ENS grant) declined in favour of AFR-FNR
2021 Supervisor's **Société de Biomécanique Young Investigator Award** (contribution as intern)

EMPLOYMENT

Post-Doctoral Researcher (CNRS ANR Rosaly)
Dec. 2025 – Nov. 2027

Laboratoire de Mécanique des Solides (LMS), École Polytechnique, CNRS, UMR 7649

- Leading poromechanical modelling and characterization of collagen hydrogels embedded with smooth muscle cells.
- Development of open-source and collaborative package for soft tissue mechanics.
- Group website (in progress): th0maslavigne.github.io/LMS_Biomechanics

Post-Doctoral Researcher
Sept. 2025 – Nov. 2025

Univ. Bordeaux, CNRS, Bordeaux INP, I2M, UMR 5295

- Extended multi-compartment poromechanical models for biological soft tissues.
- Students co-supervision.
- HPC installation of FEniCSx (MCIA cluster).

Doctoral Researcher (AFR FNR Grant N°17013812)
Sept. 2022 – June 2025

Legato Team (Univ. Luxembourg, Luxembourg) / IBHGC (ENSAM Paris, France) / I2M (Univ. Bordeaux, France)

- **Model Development:** Novel bi-compartment poromechanical framework distinguishing interstitial fluid from blood flow to simulate mechanically induced ischaemia and reactive hyperaemia.
- **Experimental Campaign:** Gender-inclusive *in vivo* campaign on 11 human volunteers combining controlled mechanical indentation with Laser Doppler Flowmetry (LDF).
- **Numerical Innovation:** "Numerical Phantom" methodology using synthetic 3D porous microstructures and EDAC-DCPSE fluid dynamics to calculate effective permeability tensors *in silico*.
- **Open Access:** Systematic diffusion through public repositories, preprints and open-access publications.
- **Collaborations:** LBTI (Lyon, France), FEMTO-ST (Besançon, France), Euler Institute (Lugano, Switzerland), LMPS (Gif-sur-Yvette, France).

Research Intern
Sept. 2021 – Sept. 2022

Legato Team (Univ. Luxembourg) & LMPS (France) — Supervisor: Pr. S. Bordas

- *Surrogate Modelling of Breast Tissue Deformation.* Adapted Digital Volume Correlation (DVC) techniques to capture breast deformation from medical CT-scans.
- *Inverse Deformation and Contact traction force field.* Inverse Finite Element simulations to identify traction force field of a deformed sample. Adaptation for an end-to-end pipeline: image processing, patient-specific meshing, inverse/forward hyper-elastic FEM.

Research Intern
Sept. 2020 – Aug. 2021

IBHGC (Ensam Paris, France) — Supervisor: Dr. P.-Y. Rohan

- *Experimental investigation of skeletal muscle tissue response to compressive loads using consolidation theory.* Development and evaluation of a poromechanical framework applied to porcine muscle compression tests. Work contributed directly to the supervisor winning the 2021 Société de Biomécanique Young Investigator Award.

Research Intern & Mechanical Engineering Projects
2019 – 2020

IBHGC (ENSAM Paris, France) & LMT Laboratory (ENS Paris-Saclay, France)

- *IBHGC (2020):* Modeling impact on pro rugby players (Supervisor: S. Laporte). Development of a Matlab model of the neck muscles to simulate head acceleration and concussion risks.
- *LMT (2019-2020):* Tomographic tracking of torsion on metamaterials (Supervisor: F. Hild) and digital volume correlation to compute strain fields. Resulted in the 2024 "Most Cited Paper Prize" from the *Journal of Strain Analysis*.

PUBLICATIONS

Peer-Reviewed Journal Articles

Sciumè, G., ..., **Lavigne, T.**, et al. *A mathematical model for two-phase flow in confined environments: numerical solution and validation. Int. J. Numer. Method. Fluids* DOI: 10.1002/fld.70030

Lavigne, T., et al. (2025). *Hierarchical poromechanical approach to investigate the impact of mechanical loading on human skin micro-circulation. Int. J. Numer. Method. Biomed. Eng.* DOI: 10.1002/cnm.70066

Lavigne, T., et al. (2024). *Poromechanical modelling of the time-dependent response of in vivo human skin during extension. Int. J. Numer. Method. Biomed. Eng.* DOI: 10.1002/cnm.70111

Lavigne, T., et al. (2023). *Single and bi-compartment poro-elastic model of perfused biological soft tissues: FEniCSx implementation and tutorial. J. Mech. Behav. Biomed. Mater.* DOI: 10.1016/j.jmbbm.2023.105902

Lavigne, T., et al. (2023). *Identification of material parameters and traction field for soft bodies in contact. Comput. Methods Appl. Mech. Eng.* DOI: 10.1016/j.cma.2023.115889

Lavigne, T., et al. (2022). *Digital Volume Correlation for Large Deformations of Soft Tissues: Pipeline and Proof of Concept. J. Mech. Behav. Biomed. Mater.* DOI: 10.1016/j.jmbbm.2022.105490

Lavigne, T., et al. (2022). *Société de Biomécanique Young Investigator Award 2021: Numerical investigation of the time-dependent stress–strain mechanical behaviour of skeletal muscle tissue in the context of pressure ulcer prevention. Clinical Biomechanics.* DOI: 10.1016/j.clinbiomech.2022.105592 **(Société de Biomécanique Young Investigator Award 2021)**

Auger, P., **Lavigne, T.**, et al. (2020). *Poynting effects in pantographic metamaterial captured via multiscale DVC. J. Strain Analysis.* DOI: 10.1177/0309324720976625 **(Most Cited Paper Prize 2024)**

Preprints, Under Review & Contributions

Lavigne, T., et al. (2025). *Synthetic Porous Microstructures: Automatic Design, Simulation, and Permeability Analysis. arXiv:2502.14518*

Abbad Andaloussi, M., ..., **Lavigne, T.**, et al. (202X) *Quantification of Glioblastoma growth induced displacement using Digital Volume Correlation: A proof of concept.* **(Under review)**

Rajabi, ..., **Lavigne, T.**, et al. *Physics-informed Dynamic Graph Convolutional Neural Network with Curriculum Learning for Pore-scale Flow Simulations.* **(In progress)** hdl.handle.net/10993/57127

Kerachni, A., ..., **Lavigne, T.**, et al. (2024). *MRI-based computational modeling of human cortical folding. Scipedia.*

Kerachni, A., **Lavigne, T.**, ..., et al. (202X). *Open-source MRI-informed computational model of human cortical folding* **Submitted.**

PATENTS & INTELLECTUAL PROPERTY

Co-Inventor — Neurosurgical Navigation System Using Physics-Informed Intraoperative Brain Deformation Tracking

Application Number: LU509777 (Luxembourg) — Status: Pending

CONFERENCES & INVITED TALKS

Oral Communications

Apr. 2026 **Euromech 670** (France). — *"Poromechanics to investigate the impact of mechanical loading on human skin microcirculation."*

Sept. 2024 **EPUAP 2024** (Lausanne, Switzerland) — *"Poro-elasticity to capture the time-dependent mechanical behaviour of in vivo human skin during an extension test."*

Apr. 2024 **Journée scientifique F2M-MSP** (Polytechnique Saclay) — *"Modélisation poro-élastique de la peau humaine in vivo."*

Aug. 2023 **BSSM's 17th International Conference on Advances in Experimental Mechanics** (Glasgow) — *"FE-based Heterogeneous Digital Volume Correlation to Measure Large Deformations of Breast's Soft Tissues."*

Feb. 2023 **Journée scientifique de la F2M-MSP** (Jussieu Paris) — *"Multiscale Modelling of the muscle."*

July 2022 **9th World Congress of Biomechanics (WCB)** (Taipei) — *"Towards real-time patient-specific breast simulations: from full-field information to surrogate model."* (Co-authored with Mazier A., et al.)

July 2022 **9th World Congress of Biomechanics (WCB)** (Taipei) — *"Modelling the apparent viscoelastic behaviour of passive muscle tissue under confined compression using a poroelastic framework."*

Oct. 2021 **46th Congress of the Biomechanical Society.** (Saint-Etienne) - *"The possible role of poro-elasticity in the apparent viscoelastic behaviour of passive muscle: a case study."*

Poster Presentations

June 2024 **PhD Day** (Luxembourg) — *"Poromechanics to account for the interplay between the mechanical and biological responses for the human skin."* **(Best Poster Award, Rank 2nd)**

Apr. 2024 **Interpore BeneLux 2024** — *"Poromechanics to account for the time-dependent behaviour of human skin during extension tests."* (Also co-authored a 2nd poster on image-informed breast tumour models).

May 2023 **18th Int. Symposium CMBBE** (Paris) — *"On the feasibility of using FE-based Digital Volume Correlation to map breast deformation."*

Invited Research Visits

Sept. 2026 **INRIA, Rennes (France)** — Planned visiting with S. Urcun.

Dec. 2024 **LKM, Erlangen (Germany)** — Invited international exchange to share PhD research findings and discuss brain mechanics with S. Budday team.

Sept. 2024 **I2M, Bordeaux (France)** — Invited to co-host the FEniCSx/GMSH mini-symposium with G. Sciumè.

ACADEMIC SERVICE & OPEN SCIENCE

Open Science & Software Development

- **Software Development:** Progressed from tutorial creation to developing a standalone Python package for porous media modelling using FEniCSx. These resources initiated international collaborations (e.g., Univ. Leeds, IMT Atlantique). Currently developing a new package dedicated to soft tissue modelling.
- **Public Repositories:** Maintainer of 5 active GitHub projects: Dolfinx_Porous_Media, FEniCSx_GMSH_tutorials, Skin_porous_modelling, 2-compartment-LDF, and Synthetic Porous Media Generation. These repositories include all in vivo anonymized experimental data, in silico generation scripts, and simulation models.
- **Certification:** MOOC *"Recherche reproductible : principes méthodologiques pour une science transparente"* (Inria / FUN-MOOC).

Academic Service & Event Organization

- **Peer Reviewer:** Active reviewer for the *Journal of Biomechanics* and *Applied Mathematical Modelling*.
- **Symposia & Conferences:** Co-Organizer & Animator of the FEniCSx-Gmsh Training Symposium (I2M Bordeaux, Sept. 2024). Organizing Committee Helper for the CMBBE 2023 Congress (ENSAM Paris, May 2023).

Scientific Outreach & Communication

- **Publishing & Education:** Co-authored the physics prep book *Oraux corrigés et commentés de Physique-Chimie PSI/PSI** (ELLIPSES). Conducted science outreach for high school students via Eduscol.
- **Digital Media:** Developing the website for the joint LMS subgroup. Previously managed the Legato Team laboratory website and YouTube channel.

TEACHING & SUPERVISION

Student Co-Supervision
2025 – 2026

LMS, École Polytechnique, CNRS, UMR 7649

- **Gaspard Deremble (L3):** Computational modelling of the cornea. Supervised the development of advanced meshing methods and the implementation of a hyper-elastic material parameter gradient to optimize and compare with experimental corneal inflation tests.
- **Parsa Namazian (M1):** Poromechanics of hydrogels. Supervised the study of cellular realignment within hydrogels during contraction.
- **Software Engineering Mentorship:** Trained both students in collaborative development practices (Git), emphasizing reproducibility, CI/CD testing, documentation via work items, and rigorous code review processes.

Research & Computational Mentorship
2024 – 2025

Univ. Bordeaux, CNRS, Bordeaux INP, I2M, UMR 5295

- **Matthieu Lacour (M2 & PhD):** Co-supervised his M2 internship (2024) on micro-fluidic chips design, and currently providing advanced computational mentoring for his PhD (2025) on Finite Element modelling using FEniCS.
- **Laura Liquette (Contractual Researcher):** Providing computational supervision and technical support for FEniCS-based Finite Element modelling.

Lecturer & Teaching Assistant
2022 – 2025

ENSAM Paris

- Delivered **75 hours of teaching** across L3, M1, and M2 levels.
- Courses included: Mathematics (L3), Basics in Solid Mechanics (M1), Finite Element Modelling (M1), Experimental Methods (M2), and Dynamics (M2).

Academic Tutor
2020

ENS Paris-Saclay

- Provided tutored sessions for M1 students requiring additional academic support.

Oral Examiner (*Khôlleur*)
2018 – 2020

Lycée Hoche, Versailles

- Weekly oral examinations in Physics, Chemistry, and Engineering Sciences for *classes préparatoires* students.

TECHNICAL SKILLS & LANGUAGES

Programming & Software	Python, FEniCSx, Matlab, C++ (Basic), Cast3M, Abaqus, Mathematica (AceFEM/AceGEN), CATIA, SolidWorks, Slicer3D, Git, HPC, LaTeX
Specialised Methods	Digital Volume Correlation (DVC), Finite Element Method (FEM), Medical Image Processing
Languages	French (Native), English (CAE C1 Advanced), Spanish (Basic)

PERSONAL INTERESTS

Cycling | Scuba-Diving (3rd Level National License) | Skiing | Guitar | Photography