

## Post-Doctoral Fellowship in Biomechanics - Investigation of Microstructural Damage in Perineal Tissue at IMT Mines Saint-Etienne and Université de Montpellier – 24 months

### PARTNER 1: SAINBIOSE, IMT MINES SAINT-ETIENNE

The SAINBIOSE Unit (SAnté Ingénierie BIOlogie Saint-Etienne) combines researchers from Jean Monnet University, Mines St Etienne, the French Blood Establishment, and the Saint-Etienne University Hospital, focusing on osteo-articular biology, soft tissue mechanobiology, and hemostasis-thrombosis. It hosts 48 permanent researchers and 37 technical staff, organized into two teams, and trains 58 PhD students. Over the last five years, it has produced 100 annual publications, filed 6 patents, developed 3 software tools, and launched 2 startups. The "Soft Tissue Biomechanics" group is led by Pr. S. Avril, and focuses on numerical, clinical, and experimental studies on the mechanical behavior of biological tissues and their interactions with medical devices. The lab includes experimental equipment such as uni- or bi-axial tensile machines, optical field measurement tools and microscopy devices. Their research is backed by a strong academic network, both nationally and internationally, and they collaborate regularly with companies like Thuasne, Sigvaris, and Medtronic.

### PARTNER 2: LMGC, UNIVERSITÉ DE MONTPELLIER

The Laboratoire de Mécanique et Génie Civil (LMGC) is a joint research unit of the Université de Montpellier and CNRS, established in 1991 at the St. Priest research site in Montpellier, with approximately 120 members, including researchers, engineers, and PhD students. The lab specializes in the mechanical modeling of materials and structures. Within 7 different research teams, the BIOTIC team (Biomechanics of Interactions and Organization of Tissues and Cells) focuses on biomechanics, particularly the mechanical behavior of soft tissues and cellular behavior and the development of implantable medical devices. The BIOTIC team collaborates closely with other LMGC teams on biomechanics-related topics and with the Montpellier University Hospital (CHU), involving two of its PUPH members, an interdisciplinary approach extends to multiple collaborations as internally with ThermoMechanics of Materials team, focusing on thermology applied to healthcare, and the Innovative Structures, Geomaterials, and Eco-construction team, which provides expertise in structural mechanics.

### POSITION DESCRIPTION

This post-doctoral fellowship is part of the large **PELVITRACK project**, funded by the **EIC Pathfinder Open** starting in mid-2025. The project aims to develop an innovative real-time solution to monitor the perineum, aiming to prevent Pelvic Floor Disorders (PFD). PFD affects up to 32% of women and 16% of men, often due to perineal trauma during childbirth in women, leading to chronic pain, incontinence, and prolapses[1],[2]. Currently, there are no clinical tools available for real-time assessment of pelvic tissue damage, often resulting in delayed decision-making and irreversible damage. **PELVITRACK** brings together an interdisciplinary and international consortium of 12 partners across multiple European countries, focusing on the development of an advanced monitoring technology to improve diagnosis, prognosis, and prevention of pelvic floor disorders. The project will specifically track changes in the physical properties of the perineum over a lifetime using mechanical, computational, and clinical approaches. The role of the postdoctoral candidate is primarily experimental, working as a part of a larger team to the development of models. This presents an ambitious challenge and opportunity to contribute to innovative research at the intersection of mechanics and imaging for healthcare [3],[4].

Research objectives and methodology:

**1. Mechanical testing of porcine perineal tissues.** The postdoctoral fellow will conduct controlled mechanical tests on entire porcine perineum and isolated perineal tissues up to failure. These tests will include uniaxial, biaxial, and bulge inflation tests to progressively replicate the physiological conditions observed during childbirth. The goal is to characterize the fundamental elastic and rupture mechanisms of perineal tissues.

**2. Optical tracking and microstructural analysis.** During mechanical testing, optical tracking will be used to capture 3D strain data through Digital Image Correlation. Additionally, changes in microstructure under load will be examined using Optical Coherence Tomography (OCT) and histological analysis to monitor tissue integrity and microstructural changes in real-time. The goal is to link microstructural changes with macroscopic mechanical behavior.

**3. Development of mechanical models.** Based on the experimental data, the postdoc will be involved, with a larger team (University of Zaragoza and IMT Ales), in the development of a constitutive model that includes the anisotropic, hyperelastic response of this complex structure together with tissue softening and damage mechanisms, using for example the phase-field approach. His/her focus will be on linking macroscopic mechanical behavior with microscopic changes to predict tissue damage. The model will be adjusted, calibrated, and validated using data from multi-axial experiments to replicate the stretching and tearing observed during ex vivo vaginal delivery. This modeling work will aim to identify mechanical biomarkers for predicting tissue damage.

### REQUIRED QUALIFICATIONS

- Recent PhD in Biomechanics, Mechanical Engineering, or a related field
- Strong background in experimental solid mechanics and biomechanical modeling
- Experience in mechanical testing (e.g., uniaxial/biaxial tensile tests, DIC, micro-mechanics or rupture)
- Experience in Finite Element Analysis (e.g. Abaqus, Ansys, Fenics)
- Proficiency in programming languages (e.g. Python, MATLAB) for data analysis and numerical model development
- Fluent communication in an international background and ability to work in an interdisciplinary team

### POSITION DETAILS

- Duration and Location: **24-month CDD** (fixed-term contract) in **2 locations**, 12 months at Université de Montpellier (LMGC) and 12 months at IMT Mines Saint-Etienne (SAINBIOSE)
- Start Date: Expected start date is **April-May 2025**
- Salary: aligned with French public sector standards

### APPLICATION PROCEDURE

- Candidates are invited to submit the following documents:
  - Detailed CV with a list of publications, and a copy of your diplomas
  - Cover letter highlighting relevant experience and motivation for the research project
  - Contact information for at least two academic references
- Applications should be sent to: Dr. Baptiste Pierrat [baptiste.pierrat@mines-stetienne.fr](mailto:baptiste.pierrat@mines-stetienne.fr) (IMT Mines Saint-Etienne) and Dr. Cristina Cavinato [cristina.cavinato@umontpellier.fr](mailto:cristina.cavinato@umontpellier.fr) (Université de Montpellier), or directly submitted on the RECRUITEE platform.
- Deadline for application: **28 February 2025**

### **REFERENCES**

- [1] K. A. Kenne, et al, Prevalence of pelvic floor disorders in adult women being seen in a primary care setting and associated risk factors, *Sci. Rep.*, vol. 12, n° 1, p. 9878, juin 2022, doi: 10.1038/s41598-022-13501-w.
- [2] R. Worman, et al, Methods used to investigate tone of pelvic floor muscles in pelvic health conditions: A systematic review, *Continence*, vol. 6, p. 100593, juin 2023, doi: 10.1016/j.cont.2023.100593.
- [3] B. Gachon, et al, Tissue biomechanical behavior should be considered in the risk assessment of perineal trauma at childbirth, *Arch. Gynecol. Obstet.*, vol. 300, n° 6, p. 1821-1826, déc. 2019, doi: 10.1007/s00404-019-05369-5.
- [4] R. Moura, D. A. Oliveira, M. P. L. Parente, N. Kimmich, et R. M. Natal Jorge, A biomechanical perspective on perineal injuries during childbirth, *Comput. Methods Programs Biomed.*, vol. 243, p. 107874, janv. 2024, doi: 10.1016/j.cmpb.2023.107874.