PHD POSITION OFFER – 36 MONTHS (Q4 2025 – Q3 2028)

CONCEPT DEVELOPMENT AND VALIDATION OF A PARTIALLY BIORESORBABLE TEXTILE-BASED IMPLANT FOR FEMALE PELVIC ORGAN PROLAPSE (POP) TREATMENT: AN INNOVATIVE APPROACH COMBINING ADVANCED NUMERICAL MODELLING AND CONTROLLED PRECLINICAL TRIALS

RESEARCHER PROFILE

■ PhD / R1: First stage Researcher
❑ Postdoc / R2: PhD holders
❑ Researcher, Assistant Professor/ Senior Lecturer / R3: Established Researcher
❑ Professor, Tenure track / R4: Leading Researcher

RESEARCH FIELD(S)[1]: Engineering, Computer Science
MAIN SUB RESEARCH FIELD OR DISCIPLINES[1]**:** Medical Sciences

JOB /OFFER DESCRIPTION

Host institution

The **Laboratory of Applied Biomechanics (LBA)** is a joint research unit of the University Gustave Eiffel and Aix-Marseille University, located within the Faculty of Medicine on the North Hospital-University Campus in Marseille. Its research program is based on the biomechanical modelling and simulation of the human body (Virtual Human) for health, sports, and safety applications. The laboratory's objectives include understanding trauma mechanisms to improve prevention and treatment of resulting injuries, and enhancing medical devices and associated surgical techniques.

Clinical context

Female pelvic organ prolapse affects nearly one in three women to varying degrees. It represents a major societal challenge. Complication rates after surgery remain very high regardless of the techniques and materials used. A better understanding of the influence of mechanical factors is required to design innovative textile based implants and improve clinical outcomes.

Scientific context

This PhD research is part of the 3 year **Excellence Chair program "Innovative Materials for Human Body Applications"** funded by the **A*Midex foundation** and initiated in January 2025 (https://www.univ-amu.fr/fr/public/actualites/decouvrez-les-nouveaux-laureats-des-appels-projets-amidex-decembre-2024). 5 full time equivalent researchers are planned to be recruited. More specifically, this PhD thesis concerns the work packages dealing with the improvement of female pelvic organ prolapse (POP) treatment with innovative partially resorbable medical textiles.

Objective

The PhD objective is to establish the proof of concept of partially bioresorbable textile based implants compatible with the mechano-biology of pelvic organ tissues in the context of female POP treatment. Special attention will be paid on understanding, characterizing and modelling the biomechanics of human repaired pelvic soft tissues after POP and those of an animal model to be tuned and optimized before any use.

Collaborations

This PhD thesis is a multi-disciplinary research project. Clinical guidance and support will be provided by the Marseille University Hospitals (APHM) and Charles University Hospitals (Czech Republic). Pre-

clinical trials will be designed and run in partnership with some veterinary organisations. Close collaborations are planned with the New Technologies Research Center (NTC), University of West Bohemia BWU (Czech Republic) for the development of the digital models. NTC will potentially host the doctoral student for a period of several months up to a year. In addition, partnerships are considered with LabTau (INSERM U1032, Lyon) for its expertise in passive elastography and the company FEG Textiltechnik mbH (Germany) for its technical support and the supply of visible textile implants.

Main work packages, phases and deliverables (provisional timeline)
The PhD student will benefit from LBA's expertise in running pre-clinical trials and modelling human bodies. Support is expected from some post cdocs and interns recruited along the Chair.

WP1: Modelling of healthy, prolapsed and repaired human pelvic organs and simulation of physiological activities	
Start date (month year): Oct 2025	End date: Dec 2026
Objectives: Multi-scale characterisation of the mechanical states of the repaired pelvic organs of human subjects	
Based on data available in the literature or shared by partners, the LBA's healthy pelvic organ model will be improved, verified and validated. A damaged version will also be derived, verified and validated. This model will then be combined with some in house numerical models of textile based implants. Relevant physiological activity cycles will be simulated. The AMSE Verification Validation 40 standard will be applied. The stress/strain states of the repaired areas at the micro/meso/macro scales (biological tissues + implants) could then be established and serve as targets for the pre-clinical model to be developed. At this stage, biological tissue processes, such as ingrowth and remodelling, will not be taken into account. Particular attention will be paid to cover a patient population.	
Deliverables (Month): State of the art (Dec 2025), article #1 submitted (Oct 2026), WP1 report (Dec 2026)	

WP2: Modelling of healthy, prolapsed and repaired pelvic organs of an animal model, simulation of physiological activities in stabling conditions	
Start date (month year): July 2026	End date (month year): Dec 2027
Objectives: Ensure the biomechanical relevance of the animal model in stabling conditions for prolapse treatment investigation	
The work will consist of characterizing and modelling the biomechanics of the healthy, prolapsed and then repaired pelvic sphere of the chosen preclinical animal model. The stabling conditions and activities will be studied and documented. Non-invasive measurement methodologies will be developed and validated. Some "smart" textile evaluated in the Chair for safety applications may eventually be used to enrich the understanding of the phenomena. The AMSE VV40 standard will also be applied. As for the WP1, the stress/deformation states of the repaired tissues at the micro/meso/macro scales {biological tissues + textile implants} will be established during an activity cycle and in the absence of integration or remodelling of the tissues. Optimization loops will then be initiated until similar stress states are obtained between the human subjects and the animal model. The exercises/loads imposed during an activity cycle and/or the choice of the animal model implantation site will constitute the adjustment variables. Animal protocols will have to be approved by relevant pre-clinical committees.	

Deliverables (Month): State of the art (Oct 2026), article #1 published (March 2027), article #2 submitted (Sep 2027), WP2 report (Dec 2027)

WP3: Optimization of a biocompatible bioresorbable textile based implant for female POP treatment	
Start date (month year): July 2027	End date (month year): Sep 2028
Objectives: Validate the relevance of the pre-clinical model and establish the proof-of-concept of a bioresorbable textile based implant	
In close collaboration with one or several manufacturers and clinicians, "positive" (successful) / negative (failed) clinical reference implants and innovative bioresorbable candidates will be selected. A preclinical study will be undertaken with the optimized animal model. Mechanical and histological characterizations will be performed at 2 and 6 months after surgery. Comparing the results obtained for the reference implants with their clinical outcomes will enable to assess the global relevance of our approach. Provided satisfactory results, candidate optimization will be initiated. Close collaborations with manufacturers will be considered to pursue this optimization work.	
Deliverables (Month): State of the art (Oct 2027), article #2 published (Marc 2028), article #3 submitted (Sep 2028), Final PhD report (Sep 2028), PhD defense by Dec 2028	

Scientific challenges and innovative methods

- The ***complex shape of pelvic organs and their inter-connections*** make their MRI image segmentation and their geometrical modelling particularly challenging. Furthermore, the numerous contacts they have with each other result in high computational times to run simulations. To overcome these challenges, the doctoral project will use **AI** to generate accurate geometries adapted to regular meshes and to lead the way to model reductions. AI methods are currently being developed and implemented within the LBA by expert AI researchers who recently joined the laboratory. They will assist the PhD student in this task..
- ***Pelvic organ tissues*** have been extensively characterized but data were mostly collected from post-mortem subjects. To access, over time, to the *in vivo in situ* properties of pelvic tissues and textiles implanted, ***passive elastography*** will be used in collaboration with LabTau/INSERM.
- The pelvic floor muscles and the ligaments of the pelvic organs play a critical role for both the statics and dynamics of the pelvic organs. However, the ***state of muscular contraction***, precise ***locations of the insertions of these ligaments*** is difficult to assess with MRI. A ***reverse method approach*** is required. To limit the number of unknowns, non-invasive pressure measurement within the pelvic sphere and the use of ***MRI visible Dynamesh implant*** (FEG TextilTechnik) will be considered.
- Finally, this doctoral project calls for numerous modelling hypotheses that need to be clearly formulated and their impact on the results of interest must be quantified. In order to ensure the reliability and robustness of the simulations, ***VV40 standard (ASME, 2018)*** will be implemented. This standard provides a framework and a rigorous approach for model verification and validation. Its implementation is now required by the FDA for any numerical simulation results as part of a Medical Device submission dossier.

TYPE OF CONTRACT: ❑ PERMANENT ■ TEMPORARY ❑ TO BE DEFINED
JOB STATUS: ■ FULL TIME ❑ PART TIME ❑ NEGOTIABLE
HOURS PER WEEK: 35h
APPLICATION DEADLINE: 11/07/2025

ENVISAGED STARTING DATE: October 2025
ENVISAGED DURATION: 36 months
IS THE JOB FUNDED THROUGH AN EU RESEARCH FRAMEWORK PROGRAMME? ❑ YES ■ NO

HOW TO APPLY
Frédéric Turquier (Full Professor, Aix-Marseille University)
E-mail: frederic.turquier@univ-amu.fr
Website: https://lba.univ-gustave-eiffel.fr/
Vít Nováček (Senior Researcher, University of West Bohemia in Pilsen)
E-mail: vnovacek@ntc.zcu.cz
Website : https://www.ntc.zcu.cz/en/Research/Research_topics/Human_Body_Models.html

WORK LOCATIONS:
The primary location will be the Laboratory of Applied Biomechanics / Aix-Marseille University – Gustave Eiffel University; Faculté des Sciences Médicales et Paramédicales - Secteur Nord, 51 Bd Pierre Dramard F-13015 Marseille, France.
The secondary potential location (several months up to a year) will be the New Technologies – Research Centre, Teslova 5b, 301 00 Pilsen, Czech Republic.

WHAT WE OFFER: Gross salary of 2 300 € per month (year 2026), opportunity to initiate a research career in a laboratory that has gained international recognition and influence in human numerical simulations for health and safety application over the past decades (https://lba.univ-gustave-eiffel.fr/).

Additional information: The Euraxess Center of Aix-Marseille Université informs foreign visiting professors, researchers, postdoc and PhD candidates about the administrative steps to be undertaken prior to arrival at AMU and the various practical formalities to be completed once in France: visas and entry requirements, insurance, help finding accommodation, support in opening a bank account, etc. More information on AMU EURAXESS Portal

QUALIFICATIONS, REQUIRED RESEARCH FIELDS, REQUIRED EDUCATION LEVEL, PROFESSIONAL SKILLS, OTHER RESEARCH REQUIREMENTS
- Master 2 Research in mechanics/biomechanics or equivalent required,
- Solid theoretical foundation in continuum mechanics
- Experienced in Finite Element numerical modelling (non linear simulation would be a plus)
- Open to contributing to pre-clinical investigations

Soft skills: Autonomy, Teamwork, Analytical and critical thinking, Strong written and oral ability, French C1 level and English B2 (or English C1) required

REQUESTED DOCUMENTS OF APPLICATION, ELIGIBILITY CRITERIA, SELECTION PROCESS
- CV, list of publications and a minimum of 2 references
- Selection will be based on knowledge in continuum mechanics, experience in the field of material/structural modelling and ability to engage in the Chair of Excellence program,
- Application closure by July 11th 2025, in-person or videoconference interview process completed by end of July 2025, final selection by end of September 2025 pending on Amidex committee validation