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

CONCEPT DEVELOPMENT AND VALIDATION OF A 'SMART' TEXTILE EMBEDDED IN A HEAD PROTECTION HELMET COUPLED WITH A DIGITAL TWIN: PREDICTION OF REAL-TIME CRANIO-CEREBRAL INJURIES TO IMPROVE EMERGENCY RESPONSE

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.

Two-wheelers head protection context

Two-wheelers accidents represent a major societal issue. In metropolitan France only, despite accounting for less than 2% of traffic, motorized two-wheelers accounted for nearly 25% of road deaths and 33% of serious road injuries in 2022. Beside, accidents involving bicycles and electric scooters increased by nearly 50% between 2019 and 2022. Furthermore, craniocerebral trauma is considered as the leading cause of death for motorcyclists and cyclists (Who, 2007). Finally, most of current research focuses on secondary safety but tertiary safety is recognized as a primary means of saving lives.

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 concerns the work packages dealing with the integration of "smart" textiles in head protection helmets to predict cranio-cerebral injuries in real time.

Objective

The goal of this PhD is to establish the proof-of-concept of a technological brick enabling, in an event of impact, the real time prediction of a helmet wearer skull& brain injuries based on embedded "smart" textiles output.

Collaborations

This PhD thesis is a multi-disciplinary research project. Coordination and transfers will be established with ***I-Safe Virtual Human*** partners. Furthermore, partnerships will be sought with helmet manufacturers for motorcyclists (SHARK-Marseille, SHOEI-Japan, ...), and cyclists (DECATHLON, …),

textile manufacturers (FEG Textiltechnik, Textinov, …) and academic laboratories (LPMT/Haute Alsace University, CIS/Mines Saint-Etienne).

Main phases and deliverables (provisional timeline)
The PhD student will benefit from the expertise and resources of the LBA's numerical and experimental platforms. Synergies for characterization and modelling will be set up with the ***LBA team*** *working* on understanding and preventing ***craniocerebral trauma in skiing/snowboarding/electric scooters*** (N. Bailly, P. J. Arnoux). Additionnal support could be offered by AI researchers who recently joined the LBA

WP1: "Smart" textile mechanical calibration	
Objectives: Set up the transfer function between the physical signals generated by "smart" textiles and their mechanical states in the context of head protection helmet impact	
Start date (month year): Oct 2025	End date: Dec 2026
Short description: This Work Package will be carried out in close collaboration with a post-doc research. "Smart" textiles and their multi-scale numerical models will be adapted and deployed into head protection helmets and their numerical models. These would have been priorly developed and validated accordingly to the VV10 ASME standards (Verification Validation and Uncertainty Propagation) approach. Embedding, size, location and orientation of "smart" textiles in the helmet will be investigated. In particular, their deployment as close as possible to the external and internal surfaces of the helmets will be considered. A dialogue between experiments and numerical simulations will be initiated with loading conditions of increasing relevance: from simple uniaxial tensile testing to complex impact conditions of real accidents (focus on 2 wheeler's).	
Deliverables (Month): State of the art (Dec 2025), article #1 submitted (Oct 2026), WP1 report (Dec 2026)	

WP2: **Head impact conditions reconstruction**	
Objectives: To replicate by inverse method the head impact conditions based on the "smart" textile mechanical states worked out in WP1.	
Start date (month year): July 2026	End date: Dec 2027
Short description: Impact conditions will be derived from the mechanical state (fields of acceleration, pressure, strain , …) of the "smart" textile. An inverse identification process will be developed and implemented using AI. VVUQ will be deployed. Sensitivity studies will be carried out.	
Deliverables (Month): State of the art (Oct 2026), article #1 published (March 2027), article #2 submitted (Sep 2027), WP2 report (Dec 2027)	

WP3: **Skull and brain injury prediction in real time**	
Objectives: To predict the risk of craniocerebral injury in the event of impact based on the signal analysis of "smart" textiles embedded in a head protection helmet	
Start date (month year): July 2027	End date (month year): Sep 2028
Short description: The LBA model {skull+brain} (Delteil, 2024) will be further developed, verified and validated for applications including two-wheeler accidents. This detailed model will be assembled with an head	

protection helmet. Then, impact conditions derived from “smart” textile output will be implemented to drive the simulation. Skull and brain response will be interpreted in terms of injury risk thanks to material based criteria published in the literature (Ji, 2014), (Sahoo, 2014). To ensure the instantaneity of numerical results, model reduction and surface response generation will be initiated using AI. Finally, an impact test involving a post-mortem human subject will be carried out to provide initial proof of concept. The prediction of lesion risks will be compared with observations of lesions on the subject.
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

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
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WORK LOCATIONS:
The 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.

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 or equivalent

- Solid theoretical foundation in continuum mechanics
- Experienced in Finite Element numerical modelling (non linear simulation would be a plus)
- Open to experimental work

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 15th 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