Call for proposals: MSCA Postdoctoral Fellowship (H/F)
Function level: Post-doc R1
Département: GeM – MULTIX

Willing to experience intersectoral, interdisciplinary and/or international research? Apply with Centrale Nantes to the MSCA Postdoctoral fellowship 2025 call for proposals and join us!

Candidate profile

We are seeking a highly motivated Postdoctoral researcher with a background in Computational Solid Mechanics. The candidate shall have a first experience in the development of numerical methods for mechanics of inelastic materials, including coding in Python and/or C++. A good knowledge of constitutive model theory, in particular for elasto-visco-plasticity, and thermodynamics of materials will be an asset.

Project description

Supervisor: Laurent STAINIER

Keywords: Data-Driven Computational Mechanics, Mechanics of Materials, Elasto-Plasticity

Topic open: Model-free data-driven approaches offer an interesting alternative to classical constitutive model-based approaches, and to machine-learning approaches. They require less training effort than the latter, and work on flexible data sets. This is specially true in the multiscale context, where data can be constructed on-the-fly from microscale information. Applying this paradigm to general history-dependent / rate-dependent behaviours still remains challenging and will be addressed in this project.

The paradigm of model-free data-driven computational mechanics (DDCM), introduced in (Kirchdoerfer and Ortiz, 2016), was later extended to history-dependent material response (Eggersmann et al., 2019). DDCM relies on the minimization of a distance between discrete constitutive data and manifolds of admissible mechanical states. In the history-dependent case, this minimization is constrained by thermodynamic principles, such as non-negative dissipation. Different parametrizations of history are possible, but they all imply similar challenges, related to the large amount of data involved.

A first challenge consists in navigating through a massive data set, for example during a nearest-neighbour search, while enforcing thermodynamic constraints. Recent work in GeM showed that encoding history and thermodynamic information through oriented graphs offers an interesting solution (Dandin et al., 2024). The principal objective of this project is to further develop and improve this concept, with the aim to address full 3d elasto-plastic simulations. A promising path could be to work on graphs of dissipation free (i.e. elastic) sets. Such a description has deep thermodynamic foundations, and at the same time should bring improved efficiency and robustness.

A second challenge lies in the data sets themselves. Accounting for history-dependence in a model-free data-driven method will require large amounts of data, independently of the specifics of the method. It is thus unrealistic to cover all loading potential paths ahead of a given simulation. DDCM can then be combined with concurrent multiscale approaches, with data generated at the microscale while DDCM solves the macroscale boundary-value problem (Karapiperis et al., 2021). In such a context, data can be generated where and when necessary, but efficiently keeping track of histories remains challenging and solving this challenge thus constitutes a second objective of the project.

Dandin, H., Leygue, A., Stainier, L., 2024. Graph-based representation of history-dependent material response in the Data-Driven Computational Mechanics framework. Comput. Methods Appl. Mech. Eng. 419, 116694. https://doi.org/10.1016/j.cma.2023.116694
Eggersmann, R., Kirchdoerfer, T., Reese, S., Stainier, L., Ortiz, M., 2019. Model-Free Data-Driven inelasticity. Comput. Methods Appl. Mech. Eng. 350, 81–99. https://doi.org/10.1016/j.cma.2019.02.016
Karapiperis, K., Stainier, L., Ortiz, M., Andrade, J.E., 2021. Data-Driven multiscale modeling in mechanics. J. Mech. Phys. Solids 147, 104239. https://doi.org/10.1016/j.jmps.2020.104239
Kirchdoerfer, T., Ortiz, M., 2016. Data-driven computational mechanics. Comput. Methods Appl. Mech. Eng. 304, 81–101. https://doi.org/10.1016/j.cma.2016.02.001

Établissement public sous tutelle du **ministère chargé de l'enseignement supérieur et de la recherche**
GROUPE **CENTRALE**

"Ecole Centrale de Nantes processes your personal data for recruitment purposes. This data is treated as confidential. Only the persons concerned by the recruitment can access the data for strictly internal purposes. The data of unsuccessful candidates is deleted at the end of the recruitment process. In accordance with the French Data Protection Act, you may obtain access to and, where appropriate, rectification or deletion of information concerning you, by contacting: dpo@ec-nantes.fr'

Call information

Organisation	Ecole Centrale Nantes
Research field(s)	Computational Mechanics of Materials
Researcher Profile	R1 – First stage researcher
Country	France
Application deadline	31 March 2025
Type of contract	Temporary
Job status	Full-time
Hours per week	39
Offer starting date (estimated)	1 Apr 2026
Is the job funded through the EU Research Framework Programme?	Horizon Europe – MSCA European Postdoctoral Fellowship

Research environment

Centrale Nantes is a top-ranked institution recognized internationally for its excellence in research and education, particularly in engineering and technology. It is known for its leadership in fields such as **marine engineering**, **civil engineering**, and **mechanical engineering**, frequently appearing in the upper echelons of global rankings. For example, it ranks **125th worldwide in Mechanical Engineering** according to the **QS World University Rankings by Subject 2024**, reflecting its prominence in this area.

Additionally, Centrale Nantes is positioned in the **top 300 globally for Engineering,** and in the **top 500 for Physical and Computer Sciences** in the **Times Higher Education World University Rankings by Subject 2024**, highlighting its multidisciplinary strength.

Notably, Centrale Nantes was named **the top institution in France in the "Engineering Schools to Change the World"** ranking, compiled by **Les Echos START and ChangeNOW**, which evaluates schools based on their contributions to social and ecological transitions. This ranking showcases its dedication to sustainability and innovative solutions to global challenges.

Centrale Nantes' research extends beyond traditional engineering disciplines. It is recognized for pioneering work in **artificial intelligence** and **robotics**, often ranking among the **top 100 worldwide** in these fields. Its **computational mechanics** and **hydrodynamics** research centers are considered among the best in Europe, further cementing its status as a leader in cutting-edge scientific research.

Through strong global partnerships and innovative initiatives, Centrale Nantes continues to enhance its reputation as a world-class institution in scientific and technological research, with a strong focus on sustainability and impactful solutions for societal challenges. Please take look at our institution before submitting your application: https://www.ec-nantes.fr/

Profile required

Eligibility criteria - Specific Requirements

- **You are a First-stage or an Experienced Researcher** eg. in possession of a doctoral degree at the time of the call deadline (10th Sept 2025) and a maximum of 8 years full-time equivalent experience in research (self-assessment tool here).
- **You comply with the mobility rule**: eg. you must not have resided or carried out your main activity (work, studies, etc.) in France for more than 12 months in the 36 months immediately before the call deadline (September 10th, 2025). All nationalities welcome!
- **You want to carry out an innovative research:** only the best proposals will be selected by the European Commission. All domains of research are eligible!
- **You already have great achievements in research:** Curriculum Vitae is an important criterion of MSCA application.

Conditions of employment

Duration	12 to 24 months
Salary	Around €6 000 (fully loaded cost of employment) per month Exact salary to be published in the MSCA PF call in April 2025.
Support to mobility and family	mobility allowance (€ 710 per month) + family allowance (€ 660 per month) if applicable - both allowances are fully loaded cost of employment
Secondment	An interdisciplinary and/or intersectoral mobility (3 months up to 1/3 of fellowship) is possible **when relevant**
Additional benefits:	- Teleworking possible - 75% transport reimbursement - Sustainable mobility bonus (if cycling or car-pooling)

Selection process
How to apply to MSCA Postdoctoral Fellowship with Centrale Nantes:

Step 1: Find a supervisor at Centrale Nantes (application before March 31st, 2025)

- *Select a pre-determined topic*: You apply **in English** to one or two research subject(s) provided by supervisors (please see table 2 below) :
    - Detailed Curriculum Vitae (including list of publications);
    - A concise statement of research's relevance to the selected topic/duration, along with a detailed proposal outlining your project idea for the MSCA Postdoctoral Fellowship;
    - Link and/or information about your doctoral thesis;
    - Contact information of two references (not mandatory, recommended).

Please apply by sending your application to pauline.rouaud@ec-nantes.fr and yolaine.lebeau@ec-nantes.fr before **March 31st, 2025**. Please always include both contacts so that your request can be processed as quickly as possible.

If your application is retained (feedback at the latest: end of April 2025), then, the next step is to apply jointly to the MSCA PF (call launched by the European Commission - HORIZON-MSCA-2025-PF-01-01).

Step 2: Prepare the application to the MSCA PF

April-May 2025
- You receive an informative MSCA-PF starter package via an online meeting with advice on institutional aspects and horizontal issues (open science, gender, ethics and research data management…) - fellow + supervisors + EU project managers
- You elaborate jointly the research approach with your supervisor(s)

June 2025
- One joint meeting in Nantes. You receive a dedicated training session "Preparing for an Horizon Europe MSCA Postdoctoral Fellowship" advice on how to write your proposal - fellow + supervisors + EU project managers

July-August 2025
- Online meeting for proofreading - fellow + supervisors + EU project managers

September 2025
- Online meeting for administrative support for your MSCA PF application - fellow + supervisors + EU project managers
- We apply for you (deadline for the application: September 10th, 2025)

Please read this page to understand how MSCA PF works: https://marie-sklodowska-curie-actions.ec.europa.eu/actions/postdoctoral-fellowships/6-steps-to-prepare-your-application

Centrale Nantes is committed to equality and diversity. In line with our CSR commitments, this call is open to all.