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

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 Scientific Computing and/or Machine Learning for engineering.

Project description

Supervisor: Lucas LESTANDI

Keywords: Physics Informed ML, ML for engineering, surrogate modeling, reduced order modelling

Topic open:

Background

The intersection of reduced order modeling (ROM) techniques and machine learning (ML) represents a critical advancement in computational science. Traditional ROM methods have evolved significantly since their inception in the 1960s. POD, first applied to fluid dynamics by Lumley, decomposed complex flow fields into orthogonal modes based on energy content. This paved the way to a host of ROMs such as POD-Galerkin, PGD or RB methods. DMD, introduced by Schmid and Sesterhenn in 2008, provided a powerful framework for analyzing temporal dynamics in complex systems for which classical ROMs struggled. Despite their many qualities, these methods remain bounded by their linear algebra backbone which limit their application to specific regions of the studied problem.

Machine learning's recent entry into this domain has opened new perspectives. Neural networks, particularly deep architectures, have demonstrated remarkable capabilities in learning complex nonlinear mappings. Physics-informed neural networks (PINNs) have shown promise in incorporating physical constraints into the learning process. Recent developments in geometric deep learning, graph NN and neural operators have further expanded the potential for handling complex geometries and operator learning.

The integration of machine learning in computational science represents a pivotal moment in scientific computing history. Computational scientists can now leverage massive investments and developments from the commercial technology sector, creating unprecedented opportunities for advancement. The development of specialized hardware for machine learning (GPUs), primarily driven by commercial applications, has created a robust ecosystem that computational scientists can readily utilize. Likewise, the software landscape offers equally significant advantages. Frameworks like PyTorch provide sophisticated capabilities essential for both deep learning and numerical simulation, including automatic differentiation, optimized computational graphs, and advanced parallelization.

Topic

During this postdoc project, you will **develop innovative approaches that combine ROM, ML, in data-driven computing solutions to transform how we tackle computationally intensive problems**. The exponential growth in available simulation data and sensor measurements presents an unprecedented opportunity to enhance traditional physics-based approaches with data-driven insights. While the **research focus** is primarily methodological, emphasizing the synergy between physics-based modeling and data-driven approaches, the specific application domain can be tailored to your expertise and interests.

In fluid dynamics and aerodynamics, we could leverage extensive wind tunnel data and high-fidelity simulation databases to enhance weather prediction models, urban flow modeling, or turbulence modeling. The structural and solid mechanics field offers rich datasets from sensor networks and material testing. In materials science, we could exploit high-throughput experimental data and simulation databases for microstructure optimization and property prediction.

The energy sector presents compelling opportunities with its wealth of operational data from wind farms and solar installations. Environmental engineering applications can benefit from satellite data and sensor networks for groundwater flow modeling, ocean circulation studies, and climate model downscaling.

If your interest lies in biomedical applications, we could utilize growing repositories of medical imaging data and patient-specific measurements to advance blood flow simulation, tissue mechanics modeling, or medical image reconstruction.

Your choice of application domain will be supported through our established collaborative networks, ensuring access to relevant expertise and high-quality datasets. The primary evaluation criteria will focus on the methodological advances you develop, demonstrating how data-driven approaches can enhance traditional physics-based modeling.

Research Challenges and Opportunities

The integration of ROM techniques with machine learning represents a rapidly evolving field where new methodologies and approaches emerge frequently. A crucial aspect of this postdoctoral project will be maintaining awareness of latest developments and building upon recent advances in the literature.

The project will address several fundamental challenges in combining ROM and machine learning approaches:

- Maintaining physical consistency while leveraging data-driven insights
- Developing error estimates for hybrid approaches
- Ensuring stability of the reduced models
- Handling multi-scale phenomena effectively

Given the fast-paced evolution of this field, we expect the specific technical approaches to be refined throughout the project, incorporating new developments from the literature as they emerge.

The key to success lies in selecting an application domain that balances scientific novelty with practical impact while remaining feasible within the project's scope and available resources. This selection will be guided by both your expertise and the latest developments in the field.

Call information

Organisation	Ecole Centrale Nantes
Research field(s)	Scientific computing, data-driven modeling, Machine learning, mechanics
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 referees.

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) (April 2025)

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.