# ***INTERNSHIP PROPOSAL***

*(One page maximum)*

Laboratory name: EDF lab, Palaiseau
CNRS identification code:
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Internship location: 7 bd. Monge, 91120 Palaiseau

Thesis possibility after internship: NO
Funding: YES If YES, which type of funding:

**Title: Quantum Algorithms for Fracture Mechanics**

Quantum algorithms for the solution of partial differential equations (PDEs) offer promising perspectives for large-scale engineering simulations. Recent work at EDF R&D has demonstrated the feasibility of such approaches on real quantum processing units (QPUs) [1,2]. The objective of this internship is to investigate quantum methods for the simulation of fracture and multi-cracking phenomena, with a particular emphasis on fault-tolerant quantum computing algorithms based on Quantum Singular Value Transformation (QSVT). The work will cover key aspects of the computational workflow, including finite-element discretization, quantum state encoding [3], tensor-network-based emulation of quantum algorithms, and the extraction of physically meaningful quantities directly from quantum-computed solutions. Particular attention will be devoted to fracture-mechanics observables such as stress intensity factors, energy release rates, and Rice's J-integral. The developed methods will be assessed on benchmark problems involving interacting cracks, with a focus on scalability, measurement complexity. The internship will be conducted within the ERMES Department of EDF R&D in collaboration with an ongoing PhD project in quantum scientific computing.

[1] U Remond, PE Emeriau, L Lysaght, J Ruel, J Mikael, K Kazymyrenko. Quantum remeshing and efficient encoding for fracture mechanics; arXiv:2510.14746, 2025
[2] S Donachie, U Remond, A Mathorel, K Kazymyrenko. Solving the 3D Heat Equation with VQA via Remeshing-Based Warm Starts; arXiv:2510.15645, 2025
[3] Lin Lin. Lecture notes on quantum algorithms for scientific computation. arXiv:2201.08309, 2022

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: NO Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: YES