

(BL100/2024-IST-ID)

Post-Doctoral Research Fellowships

Applications are open for 1 Post-Doctoral Research Fellowship(s), within the framework of project/R&D institution EUROFUSION IST-ID (1801P.01160.1.02.01) and EUPRAXIA-GA653782 (1801P.00506), under the following conditions:

Scientific Area: Plasma Physics and Nuclear Fusion

Admission Requirements: *to hold a PhD degree in Physics, experience in computational laser-matter interactions and/or quantum computing*

Workplan: 1) Getting familiar with the available quantum simulation tools of publicly available quantum computers (IBM, IonQ, etc.)

2) Quantum simulation of 0D three-wave mixing with variational error correction

The aim of this part is to introduce quantum computing solutions for application in ICF. The starting point will be the solution where the three-wave interaction with zero spatial and one temporal degree of freedom is mapped onto the quantum hardware [1].

Expected outcomes: Our team has already reproduced the results of Shi et al on quantum hardware. The candidate is expected to first run the algorithm for different initial conditions and circuit depths, in order to evaluate and characterize the decoherence error build-up. The candidate will then proceed to implement variational circuits for error correction, and evaluate their efficacy. The evaluation of accuracy will be performed on quantum hardware.

3) Quantum representation of three-wave mixing problem in 1 spatial dimension and elaborating a quantum algorithm for its unitary evolution

In this part there are two underlying research questions. First is finding the most adequate mapping of the spatial distribution to be represented on qubits. This is challenging, because there are no general solutions that naturally make the mapping between the classical and quantum representation. A second challenge is then to write the quantum algorithm for the evolution of the system.

Expected outcomes: A solution of this problem, if successful, could have implications for many different problems in fusion where three-wave interaction is important. This algorithm is expected to require a larger number of qubits (e.g. >10), which may be ran on modern QC hardware, when it becomes available for general public or academia. Meanwhile, we can evaluate the algorithm using the classical simulator of quantum circuits, and estimate the decoherence error expected for this setup.

[1] Y. Shi, A. R. Castelli, X. Wu, I. Joseph, V. Geyko, F. R. Graziani, S. B. Libby, J. B. Parker, Y. J. Rosen, L. A. Martinez, and J. L. DuBois. Quantum computation of three-wave interactions with engineered cubic couplings, 2020

Legislation and Regulations: Statute of Scientific Research Fellow, approved by Law nr. 40/2004, of August 18, as worded by Decree-Law nr. 123/2019, of August 28; FCT Regulation for Research Studentships and Fellowships, available on <https://www.fct.pt/apoios/bolsas/docs/RegulamentoBolsasFCT2019.pdf> and <https://dre.pt/application/file/a/127230968>.

Workplace: The work will be developed at GoLP of Instituto Superior Técnico, under the scientific supervision of a doctoral member of the group

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Duration: The research fellowship(s) will have the duration of 12 months. It's expected to begin in May 2024, and may be eventually renewed up to the end of the project, with the limit of 36 months, including the duration of the initial contract.

Monthly maintenance allowance: According to the values for Research Fellowships awarded by FCT in Portugal (https://www.fct.pt/wp-content/uploads/2024/02/Tabela-de-Valores-SMM_atualizacao-2024.pdf), the amount of the monthly maintenance allowance is € 1801,00, being the payment method an option of the Fellow by Wire Transfer/Check.

Selection methods: The selection methods will be the following: *Curriculum evaluation*, with the respective weight of 100%.

Composition of the selection Jury: Professor Marija Vranic, Professor Luís Oliveira e Silva and Jorge Vieira.

Announcement/ notification of the results: The final evaluation results will be communicated to all applicants by email.

Application deadline and formalization: The call is open from April 15 until April 19, 2024.

It is mandatory to formalize applications with the submission of the following documents: i) B1 Form – Fellowship application (<https://ist-id.pt/concursos/bolsas/>); ii) *Curriculum Vitae*; iii) academic degree certificate; iv) motivation letter; v) declaration on honour that the applicant does not exceed with this contract an accumulated period of three years in this type of fellowship, continuously or with interruptions, within the technological and scientific system, and that the research work that led to the PhD degree was carried out in a different entity from the host institution of the fellowship.

Applications must be submitted to the email: claudia.romao@tecnico.ulisboa.pt