# Chair of Junior Professor

**Supporting institution/organization:** Inria Research Center Saclay - Ile-de-France
Head of the institution/organization: Jean-Yves BERTHOU
Site concerned: IP Paris
Academic Region: Ile-de-France

**Partner institutions/organizations :** IP Paris on behalf of École Polytechnique and Télécom Paris

**Project name**:
**CALCUL** Qu**A**n**T**ique : InfORmation implementable on real systems

**Acronym : CALCULATOR**

**Scientific topic**:
Quantum computation at the physical-computer interface: quantum algorithms implementable on real systems

**Keywords:**
Noise robust circuits (NISQ), application cases for quantum computing, quantum algorithms implementable on specific hardware, quantum control.

**Target duration**: 6 years.
The initial Tenure Track period may last from 3 to 6 years, depending on seniority, and will be followed by tenure as INRIA Research Director after a positive evaluation.

**Profile required**: Young experienced researcher (thesis+5 or more).
See also https://www.enseignementsup-recherche.gouv.fr/cid156968/www.enseignementsup-recherche.gouv.fr/cid156968/des-carrieres-plus-attractives-les-chaires-de-professeur-junior.html

**Financial overview**: 825 000 € for the project.

**Section (s) CNU/CoNRS/CSS corresponding** : CoNRS 2, 3, 4, 27

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**Establishment strategy**:

Quantum sciences and technologies are a priority theme of IP Paris, carried out in concert with UPSaclay in the framework of the joint Quantum Institute. In Physics, activities focus on the theory of strongly correlated quantum systems, quantum simulation, quantum information and topological matter (CPHT), hybrid quantum systems and superconducting circuits (LPMC), quantum dots (LPMC), light-matter interaction (LOA) and photonic systems (LTCI) for quantum communications. The Computer Science department of IP Paris and the Inria Saclay IdF center have strong activities in the fields of semantics and classical algorithms and contributions in quantum error correction codes at LIX and within the Inria Grace team for example. Most of the activities in quantum computing are currently carried out by the LCTI team on quantum communications and networks. However, these strengths are still scattered at the present time. The present project aims to create bridges between Physics and Computer Science, by federating quantum activities at IP Paris and by creating a real synergy between the two disciplines.

**Strategy of the host laboratory**:

The project is part of the creation of a joint INRIA-IPP project-team aiming at bringing together physicists and computer scientists in the field of quantum information, initially around three researchers/teaching researchers, in theoretical computer science, experimental physics and at the interface. The role of the latter, who will have a profile as a specialist in quantum information that can be implemented on real systems, will be particularly to ensure the link between theoretical computing and realistic quantum systems. The present request for a Junior Chair concerns this key position, which is key to the success of the whole interdisciplinary initiative. The junior professor recruited will be able to develop collaborations with the IP Paris teams already in place, notably at the CPHT, LIX, LTCI and LPMC, that are developing programs on quantum simulation, potential applications of future quantum computing and quantum communications. He/she will be permanently assigned to an existing Inria team if the process of creating a joint INRIA-IPP team has not been completed one year after the date of his or her appointment. This team will be identified during the recruitment phase of the junior professor.

In addition to the administrative support of INRIA, the project team will benefit from the support (scientific, administrative and budgetary) of the DIX department and the LIX laboratory for the computer science part, and of the physics department for the physics and interfaces part. The experimental physicist will also be supported in instrumentation by the engineers of the physics department and the PMC laboratory. Complementary means could be obtained within the framework of the STEP2 project, submitted in the framework of the AAP ExcellencES.

**Summary of the scientific project:**

Although driven by the spectacular breakthroughs of the last few years, quantum computing still faces major challenges related to the processing, storage and communication of information. Given the absence, at least in the medium term, of a universal quantum computer, in the opinion of the whole community, quantum computing requires a constant dialogue between software and dedicated hardware. It is very likely that the first really useful quantum computers will be dedicated systems where the device will determine the algorithms and vice versa. Creating the conditions for a real dialogue between specialists in these two areas will therefore be a major asset in the race to the quantum computer. This is the objective of the project team that we are proposing, organized around three researchers/teaching researchers, in theoretical computer science, experimental physics and interface. The latter, whose position is the subject of this application, will be a specialist in noise-robust circuits (NISQ), in the identification of promising case studies for applications and in the development of quantum algorithms that can be implemented for a specific hardware.

**Summary of the teaching project**:

IP Paris has recently created several new programs to strengthen its offer in quantum-related topics, including a PhD Track "Quantum Sciences and Technologies" jointly run by the IP Paris Physics and Computer Science departments, a "Quantum Technologies" specialization at the M1 level in Physics, also open to students in the third year of the Polytechnique engineering cycle, and courses in the ARTeQ program jointly run by IP Paris and the University of Paris-Saclay, as part of the QUANTUM Saclay center. However, in view of the growing demand, there is a clear lack of teachers in this field. The junior professor recruited in the framework of this project will contribute to amplify and expand the teaching offer, in particular in the framework of the PhD Track and the master programs. For example, he/she will be able to teach introductory courses on quantum technologies, quantum information and quantum computation, and quantum devices, and to contribute to the supervision of projects and internships in the field. These courses will also be open to engineering students, in particular to Polytechnique students in their third year as part of the Quantum Technologies course and to students at Télécom Paris, as part of their third year program, Quantum Engineering.

**Scientific diffusion**:

The results of this project will be diffuse through publications and contributions to national and international conferences. In addition, the project may lead to the publication of software.

**Open Science**:

The project will result in deliverables (publications, software, pedagogical material) made available to the community by appropriate means (open access platforms for publications, web pages for some software, MOOCs etc).

**Science and society**:

Quantum technology is becoming a social issue and communication with the general public is essential. École Polytechnique and IP Paris, in collaboration with the departments concerned, will work on this. The precise form (and deadlines) will be worked out in consultation with the scientists of the project team.

**Indicators**:

The indicators for monitoring the project consist on the one hand of the scientific and pedagogical production of the junior professor (publications, contributions to conferences, workshops or schools, courses set up, evaluation of these courses by the students concerned, teaching material, etc.). A second aspect concerns the establishment of collaborations between the two communities concerned, physicists and computer scientists. An interesting indicator will be the number and nature of interactions between the both communities.