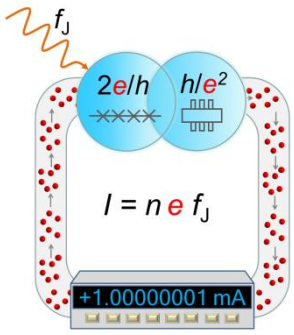
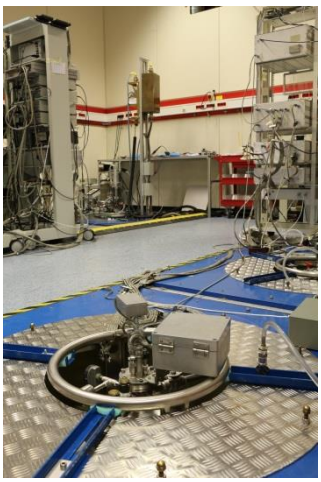
PhD Position in Quantum Metrology

Programmable quantum current generator for a renewed metrology of the ampère

LNE (Laboratoire national de métrologie et d'essais) steers and coordinates the research carried out by all French metrology bodies, working in a network with three other national laboratories. In the department of Fundamental Electrical Metrology located in Trappes (30 minutes away from Paris), the Quantum Metrology Group is advertising a PhD position with a CIFRE contract.

Our group has a long experience in the development of quantum electrical standards: world leader for the quantum Hall resistance standard (https://doi.org/10.1140/epjst/e2009-01051-5), also expert in the Josephson effect-based voltage standard (https://doi.org/10.1109/TIM.2011.2157429) and pioneer of the development of an electrical current standard based on single-electron pumps (https://doi.org/10.1103/PhysRevX.3.021012). Our group has been involved in the development of a graphene-based quantum resistance standard since 2007 (https://doi.org/10.1038/nnano.2015.192).





In a very near future the International System of units (SI) will undergo its first major overhaul since its birth in 1960. It is planned to base the SI on seven defining constants, among which is the elementary charge e. In this context, we propose a PhD project to develop a 10^{-9}-accurate programmable quantum current generator (PQCG). Directly linked to e, it will become a realization of the future SI definition of the ampere. It should lead to an improvement of the current traceability with applications spanning from fundamental electrical metrology towards highly accurate user-friendly calibrations. The first version of the PQCG has been recently demonstrated by our group, it is based on an original implementation of Ohm's law that allows to directly benefitting from the ultimate accuracy and universality of the quantum voltage and resistance standards. This relies on the exploitation of the multiple connection technique of the quantum Hall resistance standard which reduces drastically the effect of wire resistances in the circuit and on a highly exact cryogenic current comparator (CCC) used to amplify the primary current with a relative uncertainty as low as 1 part in 10^{11}. Recently we have demonstrated the accuracy of a current generated in the milliampere range to one part in 10^8, and the possibility to generate currents that can be used directly to calibrate digital ammeters from the µA range to the mA range (J. Brun-Picard et *al*, https://doi.org/10.1103/PhysRevX.6.041051).

The PhD project has the goal to further reduce the uncertainty of the PQCG and to extend the range of current, this will be demonstrated by quantization tests in the milliampere range and down to the microampere range with target relative uncertainty of 10^{-9}. The optimization will concern the improvement of the multiple connection scheme, the increase of the signal-to-noise ratio, the implementation of a cryocooled programmable Josephson voltage standard and of a graphene-based quantum resistance standard, the development of a dedicated instrumentation including the fabrication of a cryogenic current comparator and a voltage-controlled current source. The new quantum current standard will open the way toward the first demonstration of an AC version of the PQCG and the demonstration of a quantum ammeter.

For this project, we are looking for a master or engineer who knows solid-state physics and who is motivated for experimental projects with metrology challenges and instrumentation. You will work in a team of three permanent researchers with the support of a technician.

For more information, contact **sophie.djordjevic@lne.fr**. A complete application should include a CV and a short description of research interests.