Internship and PhD Opportunity:

Pioneering Random-Access Quantum Memory with Rare-Earth Ion Spins

A system able to store several quantum states, with the ability to absorb and retrieve a given state on demand, is dubbed a Random-Access Quantum Memory. Such memories can be used in quantum repeaters to improve long-distance quantum communication, but also to provide an alternate parallelism strategy in quantum processors. This PhD project will be about demonstrating high-fidelity storage of microwave quantum states using an ensemble of rare-earth ion spins.

In this internship and PhD project, the candidate will focus on demonstrating high-fidelity storage of microwave quantum states using an ensemble of rare-earth ion spins. The candidate will delve into the intricacies of the operation of a quantum memory, characterized by its storage time, efficiency, and capacity. Different platforms have already shown promise for quantum state storage, but our focus on ensembles of electron spins offers three compelling advantages:

1. **Extended Storage Times**: Experience long coherence times—up to seconds for example for electronic and nuclear spins of donors in silicon.
2. **Compact Footprint**: Our systems are by nature very compact.
3. **Multimode Storage**: Leverage advanced protocols similar to those used in optical memories for enhanced functionality.

Our current challenge is to achieve strong, adjustable coupling between the spin and superconducting circuit—a pivotal aspect of our research. We will explore a new type of spin system that promises exceptional coherence at zero magnetic field and enhanced coupling strength. The internship will center on fabricating and measuring a test sample to evaluate the performance of this innovative system during the internship. The PhD thesis will center on developing and testing a complete hybrid quantum system able to store and retrieve quantum bits generated by a superconducting circuit into the spin ensemble.

The intern will work within the framework of the RobustSuperQ PEPR (part of the French Quantum Plan) which aims at accelerating French R&D on superconducting qubits protected against decoherence. The project takes place in collaboration with a theory team in CEA-Saclay, and collaborators at ESPCI.

The internship will take place at ENS de Lyon, in the Quantum Circuit group (www.physinfo.fr). If interested, please send your resume and reference contacts to Audrey Bienfait (audrey.bienfait@ens-lyon.fr).