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Neutron Experiments on Quantum States at Pico Scale

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Perfect crystal interferometry with thermal neutrons has been a powerful tool to study foundations of quantum mechanics for almost half a century, performed at the high-flux reactor ILL at Grenoble, France, where the Atom institut (ATI) owns a permanent beamline for thermal neutrons (S18) and develops new quantum techniques at other beamlines using very-cold neutrons (VCNs) and ultra-cold neutrons (UCNs). We propose to build three new innovative interferometers, targeted at the preparation and control of quantum states. The increased sensitivity and precision of up to three orders of magnitude are achieved by advanced future setups, in particular a) a split-crystal interferometer setup for thermal neutrons, utilising the outstanding experience of nano-positioning of INRiM, b) the realization of a VCN interferometer, and c) to develop a quantum storage ring for an UCN setup, where longer interaction times are available for the quantum bouncing ball in a technically challenging gravity resonance spectroscopy setup. We endorse access to the three proposed facilities S18-IFM, VCN-IFM, and UCN-IFM for other users.

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