This project is aimed at providing a new state-of-the-art for the mathematical-physical modelling and High Performance Computing (HPC) of Quantum Turbulence (QT) in superfluid quantum fluids, such as superfluid Helium and Bose–Einstein condensates. These are very low temperature systems in which two interpenetrating fluids exist: a normal viscous flow and an inviscid superfluid flow with quantized vortices. QT is a multiscale phenomenon for which physical models and simulations covering all scales do not exist nowadays. Our cross-disciplinary project is scoped to address theoretically and numerically the critical gap between a close-up view of the interaction between normal-fluid and quantized vortices and a coarse-grained representation of QT dynamics. The final goal is to provide a new reference HPC code simulating the global QT problem at arbitrary temperature. This topic is highly strategic for fundamental research but also for future applications promising a new technological era.