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Qub-IT: Quantum sensing with transmon-based itinerant single-photon counter

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Quantum sensing is a rapidly growing field of research which is already improving sensitivity in fundamental physics experiments. The ability to measure physical quantities through quantum devices received a major boost from the application of transmon qubits and the improvements in their engineering and fabrication. The Qub-IT project goal is to realize a transmon-based itinerant single-photon counter able to surpass current devices in terms of efficiency and low dark-count rates. The Qub-IT single-photon counter will perform QND measurements, and exploit entangled qubits to surpass the state of the art performances. Such quantum sensor has direct applications in Axion dark-matter experiments. In this contribution we present the design and simulation of the first transmon of the future single-photon counter realized using Qiskit-Metal (IBM. Qiskit-Metal is a Python package that provides a user-friendly toolkit for quantum chip design and simulation. It comes with different tools to extract the circuit Hamiltonian parameters, such as, qubit resonant frequencies, anharmonicities, qubit-resonator couplings as well as an estimation for qubit decay times (T1). Qiskit-Metal is adopted by the Qub-IT quantum engineering team to tune the quantum sensor parameters in order to obtain the desired Hamiltonian before moving to the manufacturing stage.

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