An heralded single microwave photon source for the metrological calibration of quantum limited detectors

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The growing interest in fields ranging from quantum computing, to medical technology, to astrophysics for the detection of single microwave photons with very low added noise has led to the development of many different concepts of single photon detectors with growing performances. In this framework the SuperGalax project has the aim of developing a single photon microwave detector based on a network of strongly interacting superconducting qubits (Superconducting Qubits Network, SQN) which form a so-called quantum antenna. The SQN detectors need proper single photon sources to test the single photon detection ability and to characterize their behaviour. For this reason INRiM will produce a single photon source able to exploit quantum correlations to calibrate the detector in terms of quantum efficiency. The core of the single photons source will be a nonlinear transmission line embedding Josephson junctions which exploits the nonlinearity of the Josephson inductance to generate couples of single entangled photons (Signal and Idler) in the microwave range (5-15 GHz) through a Parametric Down Conversion process. The source will be sized for the calibration of the SQN in order to provide a frequency clock for the photons generation in the range of the Hz. The latter has been chosen since this order of magnitude is expected in experiments with rare events rate for which the SQN is planned to be used as a detector. The production of the single photon source will take place at INRiM in a modern fabrication facility named Piemonte Quantum Enabling Technology (PiQuET), consisting of a 500 mq ISO 6 and ISO 5 clean room.

The single photon source will be integrated with two SQNs to develop an heralded single photon source that will be tested as part of the calibration setup in the Quest for AXions (QUAX) experiment, engaged in the search of galactic axions. These calibrated SQNs will be used in the readout chain of QUAX, which exploits a resonant frequency cavity (Haloscope) immersed in a strong magnetic field to produce single microwave photons generated from the decay of axions. The protocol used for the calibration exploits a random coincidence setup which allows a complete characterization of the detectors without having any a priori information on their efficiency.