Superconducting Nanowire Single-Photon Detectors (SNSPD): application for Advanced Quantum Technologies

R. M. Ienco[1], * D. Salvoni[1,2], A. Sannino[4], F. Auriemma[3], S. M. J. Bukhari[4] and M. Ejrnaes[1, 3].

1 Qunatech SRL, Via Giacinto Gigante 174, Naples, 80128, Italy

2 Photon Technology Italy SRL, Via Giacinto Gigante 174, Naples, 80128, Italy

3 Istituto di Superconduttori e Materiali Innoviativi SPIN – Pozzuoli, CNR, Via Campi Flegrei 34, Pozzuoli, 80078, Italy.

4 Dipartimento di Fisica"Ettore Pancini", Università di Napoli Federico II, Via Cinthia 21, Naples, 80126, Italy

**rm.ienco@snspd.com*

Over the past decade, superconducting nanowire single-photon detector (SNSPD) technology has advanced rapidly, driven by continuous improvements in both device performance and experimental practicality. [1] State-of-the-art SNSPD systems now deliver exceptional figures of merit—high system detection efficiency, low dark count rates, and excellent timing resolution—even at infrared wavelengths. At telecom wavelengths such as 1550 nm, where conventional single-photon detectors experience a marked degradation in signal-to-noise ratio, SNSPDs consistently outperform the best available semiconductor-based alternatives.

Progress in cryogenic technology has played a key role in this evolution, simplifying system integration and broadening the accessibility of SNSPDs across an expanding range of research fields and industrial applications. As highlighted in this work, high-impact photon-counting experiments have been demonstrated in diverse domains, including quantum information processing, secure quantum communication, quantum key distribution (QKD) [2], and atmospheric time-of-flight ranging.

This work provides a comprehensive overview of the key performance metrics that distinguish SNSPDs from other detection technologies. We examine their impact on major quantum optics experiments, with particular emphasis on their enabling role in quantum key distribution (QKD), quantum optics and new devices design and we show our most recent results in these sectors highlighting the transformative potential of these detectors in advancing the development of quantum technologies.

References

[1] Chandra M Natarajan, Michael G Tanner, and Robert H Hadfield. Superconducting nanowire single-photon detectors: physics and applications. Superconductor science and technology, 25(6):063001, 2012.

[2] You, Lixing. "Superconducting nanowire single-photon detectors for quantum information. "*Nanophotonics* 9.9 (2020): 2673-2692.