Beyond Single-Mode Fiber: Multimode and Polarization-Maintaining Fiber Coupling for Commercial SNSPDs

J. Capua[1], G. V. Resta[1], A. Hanna[1], H. Jaffal[1], M. Perrenoud[1], T. Produit[1] and F. Bussières[1]

[1]*ID Quantique an IONQ company, CH-1227, Geneva, Switzerland*

Superconducting nanowire single-photon detectors (SNSPDs) combine high System Detection Efficiency (SDE), low timing jitter, ultralow dark count rates (DCR), and high detection rates (e.g., > 90% SDE, < 20 ps jitter, < 1 cps DCR, Photon-number resolution and ≥ Gcps in state-of-the-art systems) [1, 2]. While commercial systems commonly employ single mode fiber (SMF), several application domains benefit from multimode (MMF) or polarization-maintaining fiber (PMF), as for example: astronomy and bioimaging applications, favoring larger étendue and relaxed alignment requiring the use of MMF [3, 4] or quantum networking/quantum key distribution (QKD) applications where preserving the state of polarization motivates the use of PMF [5, 6].
Here we report on the successful integration of MMF and PMF options in IDQ's SNSPD detection technology platform. Fig. 1(a) summarizes results for MMF-coupled SNSPDs. A DCR < 100 cps with an efficiency nearing 80% at 1550 nm are the key performance parameters obtained here using a 50 µm-core multimode fiber. Blackbody photons coupled through the many modes of the MMF normally dominate DCR which can easily go over 100 kcps [7]. They are here minimized through a tailored filtering approach. This performance is on par with what SMF-coupled SNSPDs give. Fig. 1(b) reports a SDE > 80% with < 100 cps at 1550 nm using a PMF-coupled SNSPDs. Achieving high SDE is nontrivial because of preferred absorption axis of SNSPD [8] and requires good alignment.

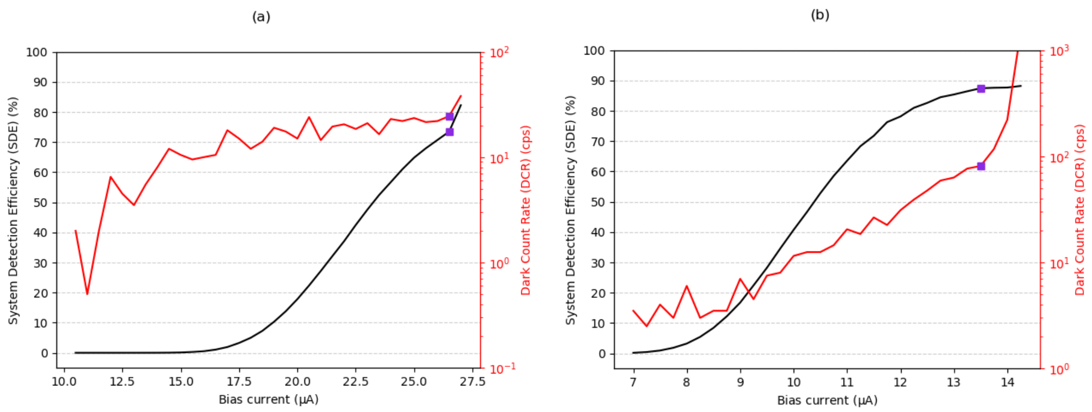

Fig. 1: (a, left) *MMF-coupled SNSPD typical SDE and DCR performance as a function of bias voltage. The violet square represents the suggested operating bias voltage.* **(b, right)** *PMF-coupled SNSPD typical SDE and DCR performance as a function of bias voltage. The violet square represents the suggested operating bias voltage.*

References

[1] F. Venza and M. Colangelo, APL Photonics 10, 040901 (2025).
[2] L. Stasi *et al.*, ACS Photonics 12, 320 (2025).
[3] E. E. Wollman *et al.*, Optics Express 32, 48185 (2024).
[4] E. C. Valmai Hughes *et al.*, arXiv:2512.07138 (2025).
[5] B. Amies-King *et al.*, Entropy 25, 1572 (2023).
[6] https://epb.com/newsroom/press-releases/protecting-quantum-signals-ornl-partnership/
[7] H. Shibata *et al.*, Optics Letters 40, 3428 (2015).
[8] Y. Fei *et al.*, Optics Express 30, 36456 (2022).