Ultrafast waveguide integrated single photon detectors

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Nanophotonic circuits employ waveguiding devices to route light across integrated optical chips in analogy to electrical wires in integrated electrical circuits. Interaction with the environment is possible through near-field coupling to the evanescent tail of propagating optical modes. This approach is particularly interesting for designing highly sensitive detectors which are able to register individual photons and constitute fundamental building blocks for emerging quantum photonics. Superconducting nanowire single photon counters (SNSPDs) provide high efficiency and good timing performance, as well as broad optical detection bandwidth. To move towards applications in high bandwidth quantum communication, we realize compact SNSPDs with sub-micrometer effective length by embedding them in photonic crystal cavities to recover high absorption efficiency [1,2]. These detectors possess sub-nanosecond recovery times and ultralow noise equivalent power. Being made by scalable fabrication techniques, waveguide SNSPDs hold promise for photonic integrated quantum technologies

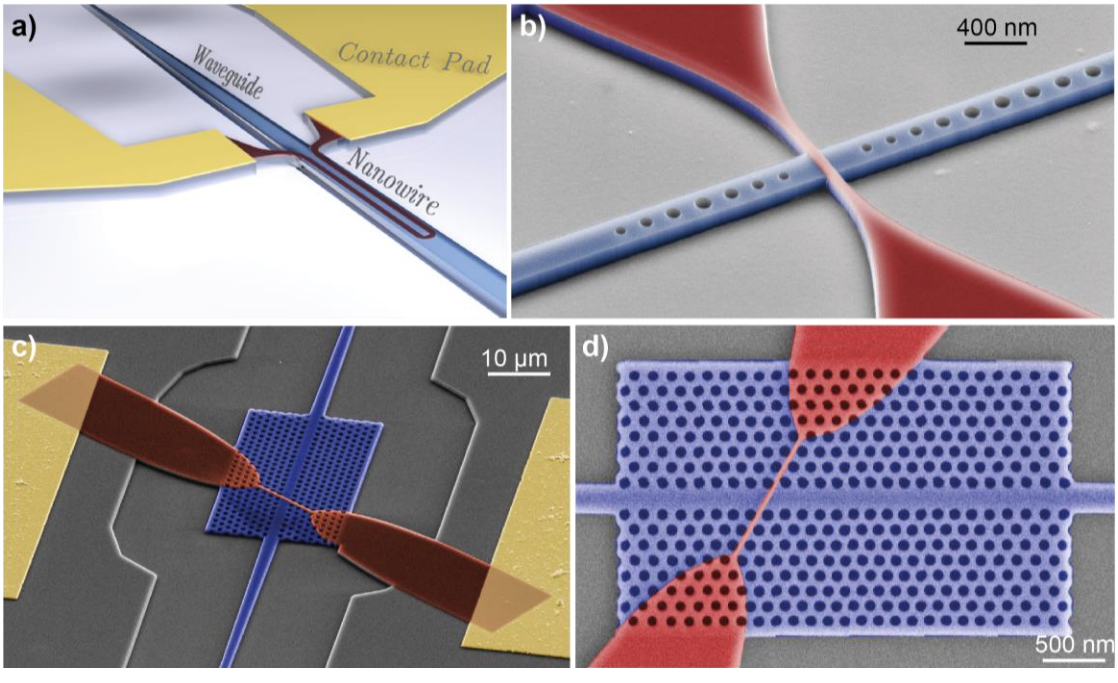

Figure 1: Waveguide-integrated single-photon detectors. a) U-shaped detector layout with speed-limiting kinetic inductance due to the nanowire length. b) Cavity enhanced bow-tie detector using perfect absorber concepts. Reset time is 110 ps. c) SEM micrograph of a cavity-integrated detector in a 2D photonic crystal double hetero cavity. d) Top view of the cavity layout showing the tilted detector layout with respect to the cavity axis

References

[1] A. Vetter, et al., “Cavity-Enhanced and Ultrafast Superconducting Single-Photon Detectors”, Nano Lett. 16, 7085 (2016).

[2] J. Münzberg, et al., “Superconducting nanowire single-photon detector implemented in a 2D photonic crystal cavity”, Optica 5, 658 (2018)