Large-area High-speed SNSPDs for Laser Ranging

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Single-photon detectors with high count rates constitute the foundation for developing remote laser ranging and communication. Although a total count rate (CR) of gigahertz has been achieved with multiple superconducting nanowires, the coupled single-mode fiber is incompatible with most large-aperture optical telescopes, and the uneven distribution between nanowires also limits system performance in practice. We have developed two types of large-area high-speed SNSPDs over the past three years. By arranging parallel nanowire structures with concentric circles, we achieved a system CR exceeding 147 Mcps, which can couple a 200-micrometer multimode fiber through ~3x beam compression. The area and maximum CR for each channel of this SNSPD are twice as high as those of previously reported results. Furthermore, we designed a multimode fiber-coupled SNSPD with a gigahertz CR through 16 intertwined niobium nitride nanowires. Overcoming the interference of speckles in multimode fibers through intertwined structures, all nanowires perform uniformly, achieving a detection efficiency of 87.6%, a maximum count rate of 1.3 Gcps when the efficiency decreases by 3 dB, and a maximum count rate of 3.1 Gcps before latching. We highlight that the two large-area SNSPDs are highly important for remote laser ranging and communication.