Pixel
Photonics

単一光子検出システム

Single photon detector system

Dena XX System
(XX = number of channels)

Integrated SNSPDs

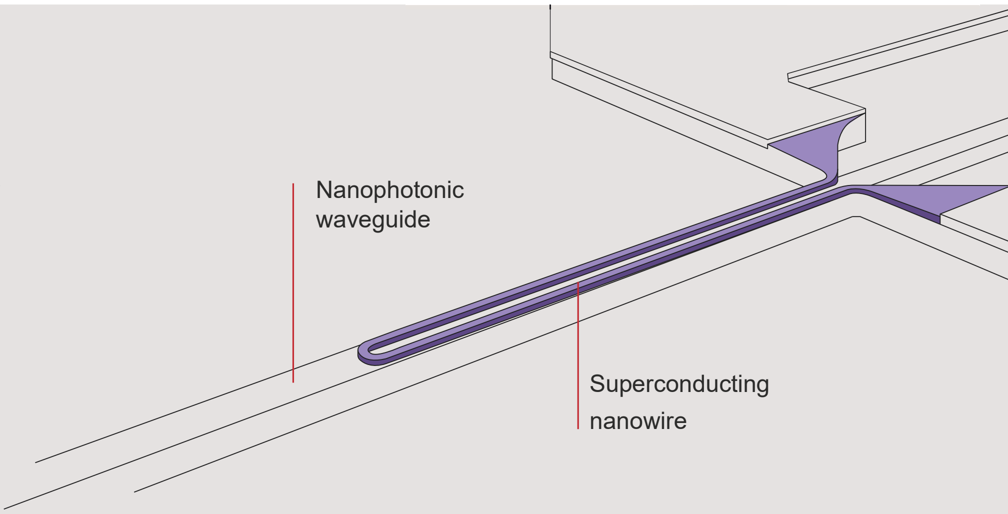
- One-button operation
- Highly parallelized
- High efficiency
- Ultra fast single photon detection

Photonic integrated circuits

- Compact photonic functionalities
- In-house fabrication
- Customer-specific individuality

WI-SNSPD

Waveguide-integrated superconducting nanowire single photon detector





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Housing system key features

Cryostat operation temperature	2.5–3 K
Cooldown time	5–8 h
Number of channels	Variable (2–64+)
Optical fiber access	Via FC or LC
Electrical readout	Via SMA
Compatibility	-Standard 19” rack solution including compressor -Desktop solution with external compressor

Detector specifications

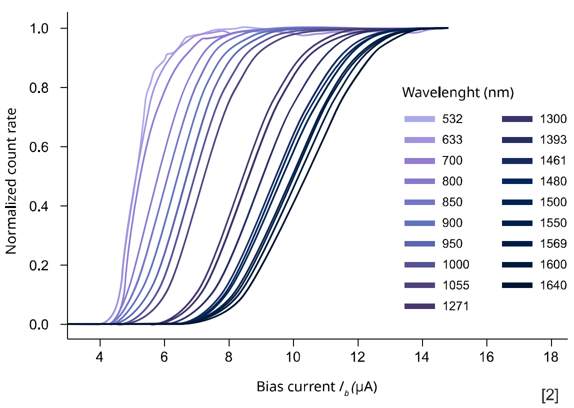
Wavelength spectrum	Visible to IR spectrum
System detection efficiency (SDE)	> 70 %
Dark count rate (DCR)	< 100 Hz
Timing uncertainty (Jitter)	< 50 ps
Max. count rate (MCR)	> 60 MHz

Upgradable

Unlatching hardware implementation	Automatic reset of the detector in case „latching“ occurs Reduction to ns compared to software implementation
Experimental QKD receiver channels	Optimized for a wavelength of 1550 nm Suitable for QKD time-based protocols such as time-bin with decoy state, differential phase shift or coherent one-way [1]

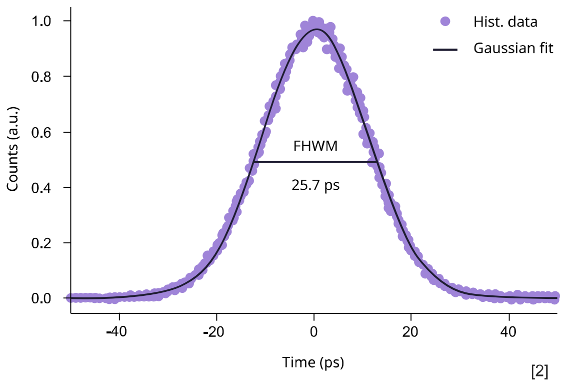
Typical performance

Saturation over a broad spectrum



[2]

Timing uncertainity (Jitter)



[2]

[1] Beutel, Fabian, et al. npj Quantum Information 7.1 (2021): 1-8.
[2] Wolff, Martin A., et al. Applied Physics Letters 118.15 (2021): 154004.

PICs (photonic integrated circuits)

The idea behind integrated photonics is to minimize optical components like, e.g., waveguides, phase shifters sources, or detectors on monolithic chips, similar to electrical integrated circuits (EICs) minimizing electrical components. Utilizing this minimization and using complementary metaloxide-semiconductor (CMOS)-compatible fabrication processes increases the scalability, stability and reproducibility while decreasing the size, enabling the manufacture of complex, densely packed devices.

Cryostat

A cryostat is a device for maintaining low cryogenic temperatures (down to mK) that allow superconducting states of materials to be realized and harnessed.

SNSPDs (superconducting nanowire single photon detectors)

Superconducting nanowire single photon detectors (SNSPDs) are sensitive for very low amounts of light down to the single photon level in a broad frequency spectrum. They consist of current-fed superconducting nanowires and offer high intrinsic quantum e ciencies, high count rates and ultra-high timing precision. They are a key technology for applications in quantumoptics and optical quantum technologies.

SDE (System detection efficiency)

The system detection efficiency is defined as the ratio between the amount of light measured (power) and the amount of light entering the fiber link. Here, the system detection efficiency is composed of the individual efficiencies of the fiber, the fiber-to-chip interfaces, the photonic integrated circuits and the superconducting detector material's absorption and internal quantum efficiency (IQE).

IDE (Internal detection efficiency)

The internal detection efficiency is defined as the ratio between the amount of light measured (power) and the amount of light entering the photonic circuit. Here, the internal detection efficiency is composed of the photonic integrated circuits' transmission losses and the superconducting detector material's absorption and internal quantum efficiency (IQE).

Dead time – maximum count rate

The dead time denotes the period after the detection of a photon, during which no further detection is possible since the detector is recovering into the superconducting state. This limits the maximum count rate.

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Jitter (Timing uncertainty)

Timing uncertainty, or jitter, is a measure of the variation in latency, or more precisely, the variation in the time between the absorption event and the registered readout event in between clicks. Three sources contribute to jitter: Firstly, the measurement setup, including readout electronics, optical fibers, photodetectors, etc. Secondly, the electronic noise. And finally, the intrinsic jitter of the detector. It is usually quantified with an r.m.s. (root mean square) value.

Dark count rate

The dark count rate is the average registered count rate without light incidence.
It determines the minimum count rate at which actual photons dominate the signal, defining the signal-to-noise ratio.

Latching

The detector remains in a non-superconducting state, so it does not recover and thus no longer detects photons. A manual or automatic reset of the detector becomes necessary.

DLW (Direct laser writing)

Direct laser writing harness multi-photon-lithography. Here, two photons are utilized to polymerize the resist. Due to the smaller cross-section of two-photon absorption, it is possible to focus the laser in small voxels, which allows manufacturing of out-of-plane structures.