Redefining Measurement

ID Qube Series: NIR

Synchronous and Asynchronous Single-Photon Detection at Telecom Wavelengths

The ID Qube NIR single-photon avalanche detector modules are a breakthrough in single-photon detection at telecom wavelengths.

The ID Qube is a cost-effective solution delivering precise and reliable single-photon detection, with high quantum efficiency, low timing jitter and low detector noise. Available in two models:

- **The ID Qube NIR Free-Running model**, for applications in which asynchronous photon detection is essential, such as photon correlation or time-of-flight measurements.
- **The ID Qube NIR Gated model**, for applications in which synchronous photon detection is essential, such as quantum communication and QKD.

All models offer a gate input port connector, dedicated to avoiding saturation or undesired detections. The cooled InGaAs/InP avalanche photodiode and associated electronics have been designed to achieve especially low afterpulsing and dark count rates.

The ID Qube NIR is available with free-space or optical fibre-coupled inputs.

Key Features

- Compact, cost-effective and dependable performance
- Fast gated (up to 100 MHz) and free-running
- Ultra-low noise (<800 cps at 10%)
- Low jitter (<200 ps, typically <150 ps)
- Free space or Fibre-coupled optical input
- Broadband detection (900-1700 nm)

Applications

- QKD and quantum communication
- Quantum optics and computing
- Single-photon source characterisation
- Fluorescence lifetime measurements
- Failure analysis of integrated circuits
- VIS, NIR and MIR spectroscopy

Available in Eight Combinations

ID Qube-NIR-***XX***-***YY***-***ZZ***

XX: GAT (Gated model) or FR (Free-running model)

YY: FS (Freespace model) or MMF (Fibre-coupled model), compatible with SMF and MMF FC/PC couplers)

ZZ: STD (Standard-noise model) or LN (Low-noise model)

Gated and free-running modes at telecom wavelengths

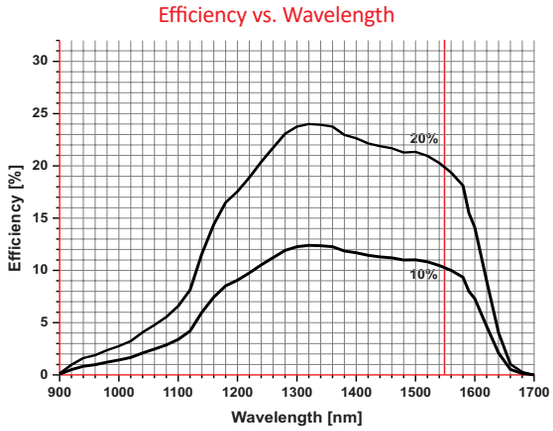
The ID Qube has been specially designed to achieve low dark count and afterpulsing rates.

The ID Qube NIR can operate at six detection efficiency levels[1][2] of 10%, 15%, 20%, 25%, 30% and 35%, with a deadtime between 100 ns and 80 µs. In gated mode it accepts gates as short as 3 ns (500 ns for the Free-running model) with a maximum repetition frequency of 100 MHz (1 MHz for the Free-running model). The arrival time of photons is reflected by a 10 ns LVTTL/NIM (user-selectable) pulse available at the SMA connector with a timing resolution typically lower than 150 ps at 25% efficiency. A simple USB interface allows the user to set the efficiency level and the deadtime.

BROADBAND EFFICIENCY

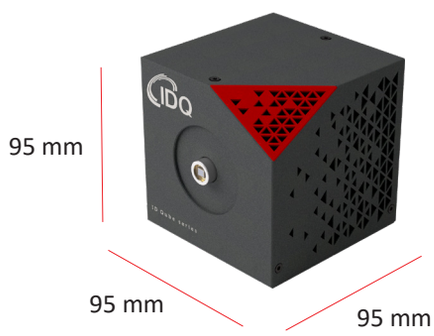
The ID Qube NIR's response characterization is carefully carried out at IDQ premises using equipment calibrated by the Swiss Institute of Metrology (METAS).

Efficiency vs. Wavelength



COMPACT

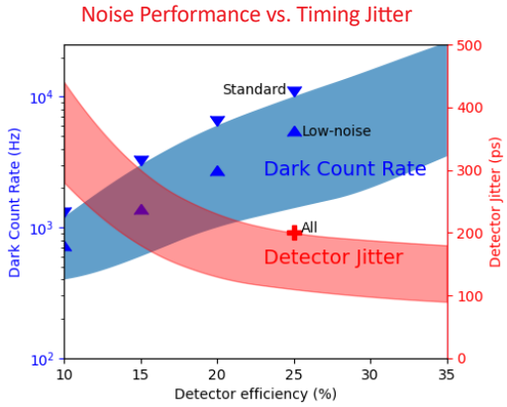
The ID Qube is small, compact and ideally suited for applications such as LiDAR, where compactness is key for system integration.



LOW NOISE

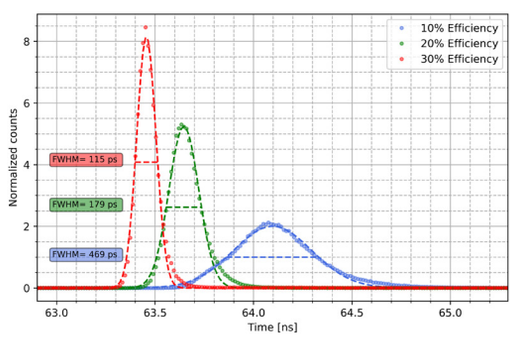
The measured dark count rate strongly depends on two factors: efficiency and deadtime. By balancing their interplay, it is possible to optimize efficiency, afterpulsing and dark count rate for each dedicated experiment.

Noise Performance vs. Timing Jitter



HIGH PRECISION

The jitter of a SPAD is greatly reduced when the quantum efficiency is increased as shown on the curve below. The ID Qube NIR offers a jitter typically lower than 150 ps at 25% efficiency at 1550 nm. The figure below shows typical jitter measurements.

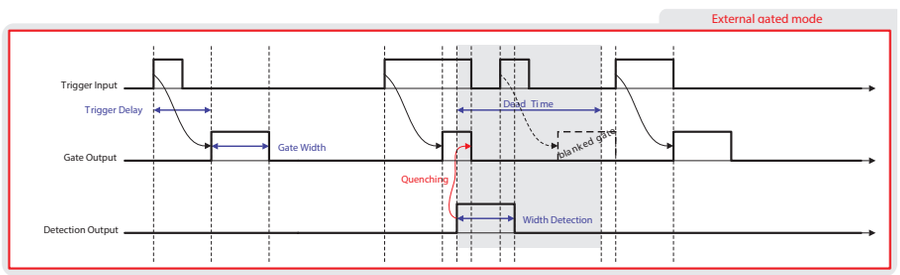


PRINCIPLE OF OPERATION

Gated operation

Gating the detector is achieved through connection to an external electrical pulse source. Both models of the ID Qube NIR can be operated with a gate signal, though only the ID Qube NIR Gated model is designed for high-speed operation, accepting a gating frequency of 100 MHz, compared to the 1 MHz of the ID Qube Free-running.

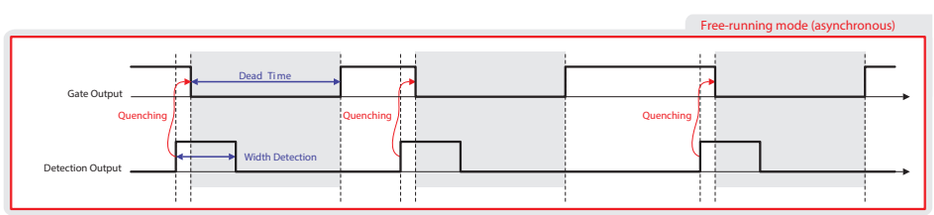
Gating—switching of the detector response—with the ID Qube NIR Gated allows for high-speed synchronisation with external signals, such laser trigger pulses in a fluorescence microscopy setup. With the ID Qube Free-running model, the slower gating capability still proves useful for blinding the detector to windows of unwanted detection, mitigating background noise.



During a gate pulse, the ID Qube NIR's avalanche photodiode (APD) is biased above its breakdown voltage. An amplitude discrimination is applied to the signal voltage using an adjustable threshold level between -2 V to +2 V, with the user choice for positive or negative pulse detection logic. In the case of small gate widths, the GATE-IN signal input can be used as a trigger to generate an internal adjustable gate width with steps of 0.1 ns. Whichever the mode chosen, a photon absorption-induced avalanche event within the gate results in the incrementation of the detection counter and an electrical pulse is generated and sent to the Detection OUT connector. The quenching electronics close the gate, halting the avalanche while an adjustable dead time is applied.

Free-running operation

All ID Qube NIR models can also be operated in free-running (asynchronous) mode. The APD is biased above its breakdown voltage in the socalled Geiger mode. Upon absorption of a photon and the associated avalanche, the photon arrival time is reflected by the rising edge of a 10 ns-wide LVTTL/NIM pulse at the Detection OUT connector. Both the ID Qube NIR Gated and ID Qube NIR Free-running have been designed to provide fast avalanche quenching, strongly limiting the afterpulsing rate (a behaviour where additional 'false' detection avalanches are triggered by the tail of a 'real' detection event pulse). This allows operation at short dead times, increasing the maximum detected count rate without sacrificing detector performance, which can be further optimized depending on the application and the efficiency level selected.



TIME CONTROLLER SERIES BUNDLE

Take your experiment to the next level. Use the Time Controller to register single-photon pulses and control the gates of up to five ID Qube detectors, within a combined time-tagger, pulse generator, delay generator package. All with advanced on-board logic for real-time four-fold coincidence measurements.

ID Qube Series: NIR

SPECIFICATIONS

ID Qube NIR				
Wavelength range	900 nm to 1700 nm			
Deadtime range	100 ns to 80 µs, in 100 ns steps			
Output pulse format	LVTTL or NIM			
Output pulse width	10 ns			
Optical coupling	Free space or optical fibre (MMF62.5)			
Efficiency range [1] calibrated at λ = 1550 nm	10%, 15%, 20%, 25%			
Extended efficiency range [2]	30%, 35%			
Timing jitter at 25% efficiency level	Maximum 200 ps (<150 ps typical)			
Max. dark count rate @ efficiency [3]	10%	15%	20%	25%
STD model (Max. dark counts per second)	1.2 kHz	3 kHz	6 kHz	10 kHz
LN model (Max. dark count per second)	0.8 kHz	1.5 kHz	3 kHz	6 kHz
Gate-in max frequency	100 MHz (Gated model) / 1 MHz (Free-running model)			
Gate-in min pulse duration	3 ns (Gated model) / 500 ns (Free-running model)			
Gate-in voltage range	-2 V to 3 V			
Gate-in coupling	50 Ω DC			
Gate-in threshold voltage range	-2 V to 2 V, in 1 mV steps			
Output connector	SMA			
Operating temperature	+10°C to +35°C, max. 60% humidity			
Dimensions (W x H x L)	95 mm x 95 mm x 95 mm			
Weight	1 kg			
Cooling time @ power-on	< 3 minutes			
Power supply	100-240 VAC; 1.4 A; 50-60 Hz			
Storage temperature	+5°C to +50°C, max. 60% humidity			

Supplied Accessories:

- +12V, 60 W, AC/DC power adapter, with AC power cord
- Region-adapted power cord
- 1.8 m USB cable
- Optical fibre cleaner (fibre-coupled model)
- C-mount adapter (free space model)
- Optical table mechanical adapter (M4 holes)
- 4 x Adhesive rubber feet

[1] Additional efficiency levels can be calibrated on demand.

[2] The extended detection range is provided without guarantees of the device's noise performance. Above 25% efficiency, ID Qube devices start exhibiting non-negligible afterpulsing, and detector dark counts can rise significantly. However, detector timing jitter has also been observed to improve with increasing detection efficiency.

[3] Dark count rate measured in free-running mode with a 50 µs deadtime.

Applicable standards

Safety US: UL 61010-1:2012 (3rd Ed.), AMD1
Safety CAN: C22.2 No 61010-1:2012 + U1:2015 + U2:2016 AMD1:2018

CE **Safety**: EN 61010-1:2010, AMD1:2016
EMC: EN 55032:2015, EN 55035:2017, EN 61326-1:2013

FC Title 47 Part 15:2019 Subpart B as a Class B device

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