pi imaging

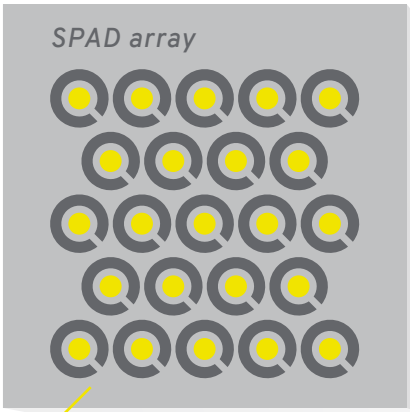
ENABLING INNOVATION

SPAD23

Description

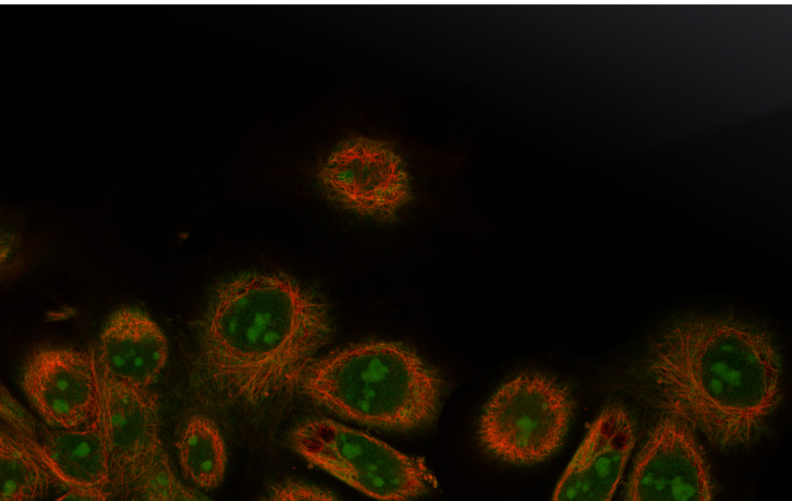
SPAD23 is a detector array with 23 hexagonally packed single-photon avalanche diodes (SPADs) with best-in-class performance.

- Optimized for a wide detection spectra and low noise
- Credit card-sized system with time tagging



A schematic representation of the 23 SPADs placed on a hexagonal grid.

SPAD23 system



Applications

Confocal microscopy

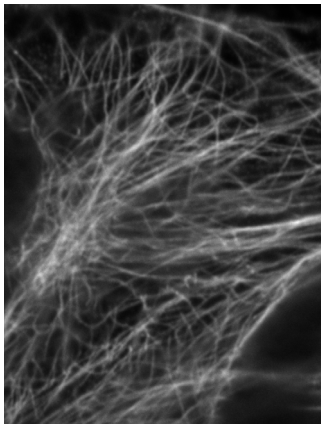
SPAD arrays increase light collection and enable innovation in the field of confocal scanning microscopy. This innovation finally leads to a sharper and brighter image with functional information about the underlying molecular function, interactions and environment.

Applications:

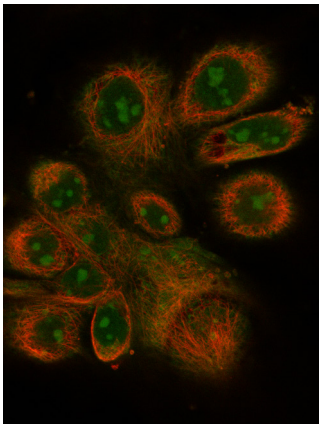
Image scanning microscopy (ISM), quantum ISM (Q-ISM), fluorescence lifetime imaging (FLIM), fluorescence correlation spectroscopy (FCS), stimulated emission depletion microscopy (STED)

Why SPAD arrays?

- Achieve super-resolution with a standard confocal microscope
- Increase light collection
- Increase imaging speed
- Reduce background noise



A confocal microscopy image.



A multi-channel confocal microscopy image.

Quantum information

Temporal photon correlations and photon number resolving (PNR) enable probing of quantum properties of light. Our detector has an extremely low crosstalk and thus enables reliable measurements of second and third order photon correlations, as well as quantum random number generation for unbreakable encryption.

Applications:

Antibunching and coincidence correlation, quantum random number generation

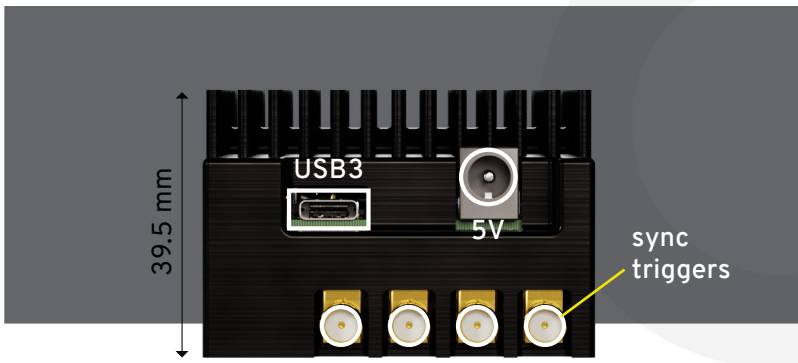
Why SPAD arrays?

- Simplify setup with single-chip multi-channel detector
- Increase data rate with detector parallelization
- Photon number resolving (PNR) detection

Operating conditions & technical specifications

Recommended operating conditions

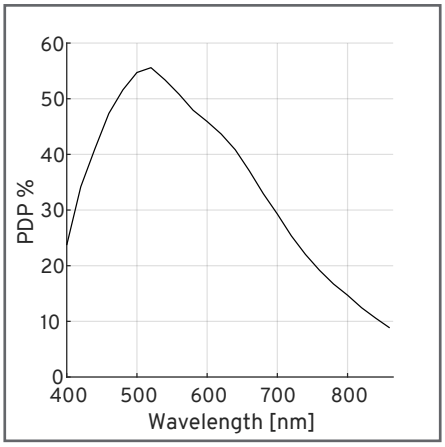
SYMBOL	PARAMETER	MIN	MAX	UNIT
Operating voltages				
V_{OP}	SPAD high-voltage	26	32	V
Environment				
T		-55	35	°C



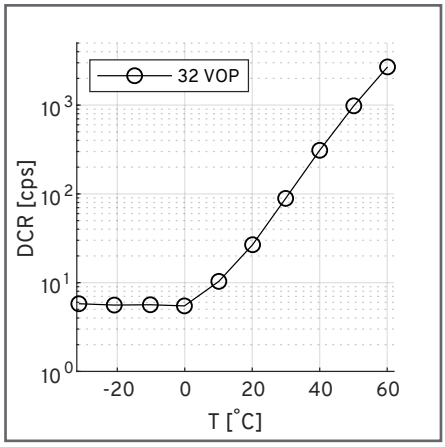
Typical technical specifications

PARAMETER	CONDITIONS	TYP
Peak detection probability	V_{OP} = 32 V	55% @ 520 nm
Wavelength window with PDP >35%	V_{OP} = 32 V	440-660 nm
Fill factor	Collimated light	> 80%
Dark count rate	V_{OP} = 32 V T = 20°C	< 100 cps
Number of noisy pixels with DCR> 1 kcps	V_{OP} = 32 V	1
Dead time	V_{OP} = 32 V V_q = 0.8 V	50 ns
Timing jitter	V_{OP} = 32 V	120 ps
Afterpulsing	V_{OP} = 32 V V_q = 0.8 V	0.1%
Crosstalk	V_{OP} = 32 V	0.14%
Maximum count rate per pixel		7.8 Mcps
Time-tagging resolution		20 ps

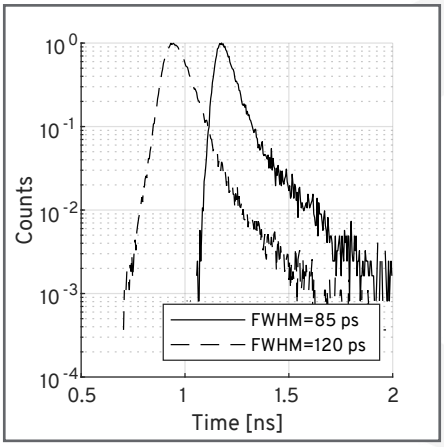
Typical performance characteristics



Photon detection probability.



Dark count rate over temperature.



Excellent timing jitter with a FWHM of <120 ps for wavelengths between 510 and 785 nm.

System integration

A system overview is shown on the right. For operation, only two plugs are required, a 5 V power supply and a USB3 connection.

The software provides functionalities for photon-counting and time-tagging modes. It can be accessed through TCP/IP for easy integration into LabVIEW, MATLAB or Python.

Credit card-sized system, housing an FPGA and the SPAD23 sensor.

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