

# Single Photon Detector

## Market Research Report

Apr. 2023



# Methodology

Industry research: By conducting interviews with relevant companies, consumers, and industry experts, we aim to understand the demand, trends, and scale of the market.

Data analysis: By collecting, organizing, and analyzing market data, including market size, growth rate, pricing trends, consumer preferences, and more, we aim to understand the current status and development trends of the market.

Competitive analysis: By analyzing information such as competitor's products, prices, and market share, we aim to understand the competitive landscape in the market and our own strengths and weaknesses.

Technical analysis: By evaluating the technical requirements and development trends of the market, including the advantages and disadvantages of single photon detector technology characteristics, we aim to gain insights into the market's direction.

Regional analysis: By understanding factors such as local consumer demands and policy environments, we aim to identify regional differences in markets and potential for development.

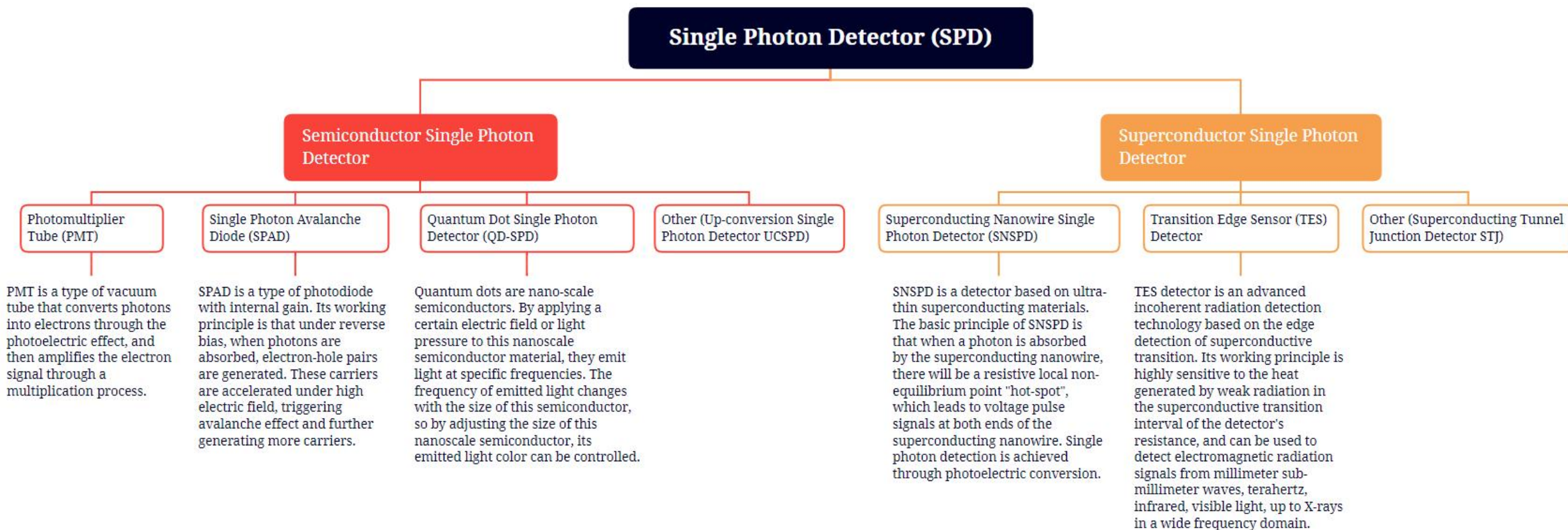
# Introduction

Single photon detector is a highly sensitive photodetector that can detect individual photons. It can count single photons, achieve detection of extremely weak target signals, and has wide applications in fields such as optical quantum information technology, eye-safe laser radar, and characterization of photon sources.

There is not only one classification method for SPD. According to the time of product technology appearance, it can be divided into traditional SPD and new SPD. For example, photomultiplier tube and avalanche detector are traditional SPDs, while Superconducting Nanowire Single-Photon Detector is a new type of SPD with significant breakthroughs in photon detection efficiency, dark count rate and other aspects. According to different working principles/materials, it can be divided into semiconductor SPD and superconducting SPD. For instance, PMT is a semiconductor-based SPD while SNSPD is a superconducting-based one.

# Classification of Single Photon Detectors

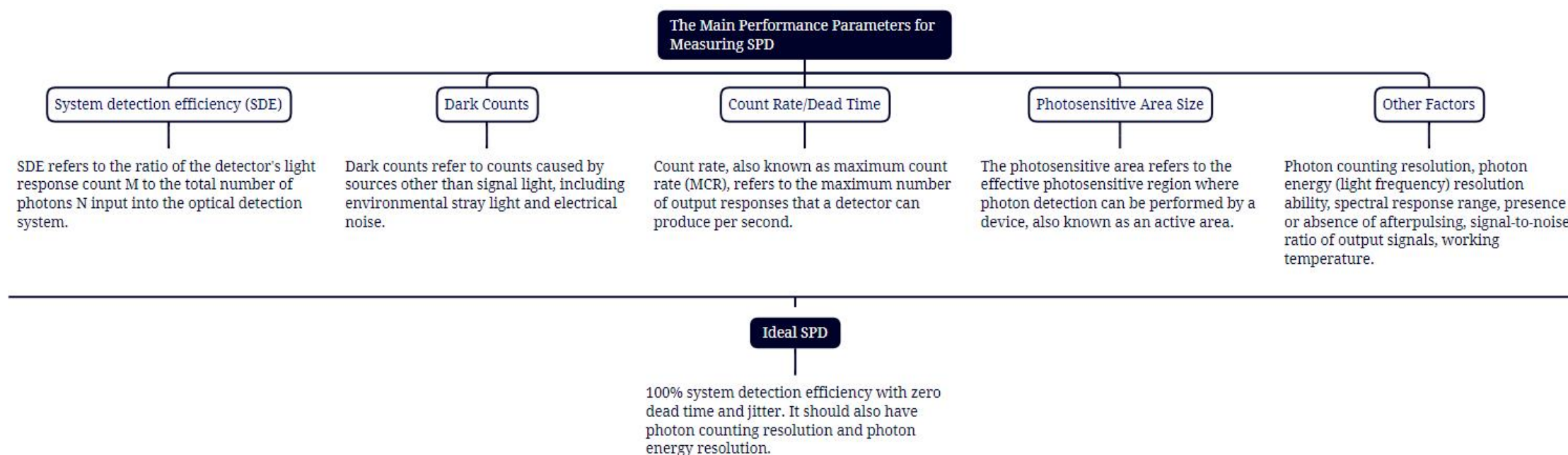
Single photon detectors can be classified into the following categories based on their materials and working principles:





# Main Performance Parameters

Single-photon detection is essential for Quantum information Science and Technology. The paramount goal is to approach 100% detection efficiency. Other performance characteristics of detectors, such as latency, timing jitter, maximum count rate, and the presence of afterpulsing may be just as important for practical quantum networks, but may be application-specific. In some cases, the ability to resolve the number of photons in a pulse may be crucial.



# Typical Parameters of Commonly Used SPDs

Detector type	Operation temperature/K	Effective area/mm	Wavelength range/ $\mu\text{m}$	System detection efficiency@ wavelength/ (%@ $\mu\text{m}$ )	Dark count rate/Hz	Timing jitter/ps	Dead time/ns	Max. count rate/MHz
PMT	300	$\Phi 5$	0.2—1	50@0.5	100	300	50	10
IR-PMT	200	$\Phi 1.6$	1—1.7	3@1.5 60@650	200000	300	50	10
Si-SPAD	250	$\Phi 0.05\text{--}3$	0.5—1.0	80@0.8 10@1.0	2000	50	100	10
InGaAs—SPAD	200	$\Phi 0.05$	0.9—1.7	25—55@1.5 >	2000	150	10—100	10—500
SNSPD	1—4	$\Phi 0.015\text{--}0.1$	0.2--9.9	80@0.2—1.5 >	100	50	50	20—500
TES	0.1	0.02×0.02	Millimeter Wave	95@0.85—1.5	0	$10^3\text{—}10^5$	1000	0.1—1

Sources: ICV TAnK

# Comparison

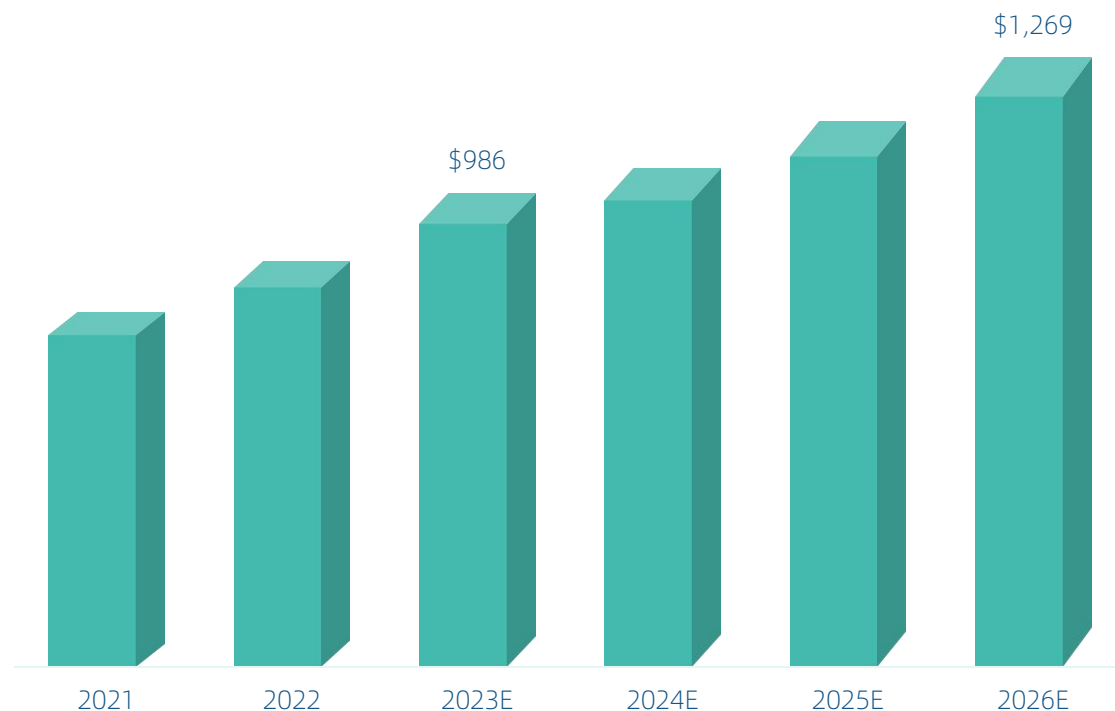
Semiconductor-type single-photon detectors have advantages such as high operating temperature, fast response speed and low dark counts. However, their quantum efficiency and time resolution are limited by factors such as material intrinsic bandgap and carrier recombination.

Superconductor-type single-photon detectors have advantages such as high quantum efficiency, excellent time resolution and extremely low dark counts. However, due to their extremely low operating temperature of approximately 4K, these systems necessitate complex cryogenic cooling.

In particular, the main difference between single photon detectors in the near-infrared band and superconducting nanowire single photon detectors lies in their working principles and performance characteristics. Near-infrared single photon detectors are typically based on semiconductor devices, while superconducting nanowire single photon detectors use the properties of superconductive materials to achieve high resolution, count rate, and low dark count rates. However, they can only detect photons between visible light and near-infrared wavelengths.

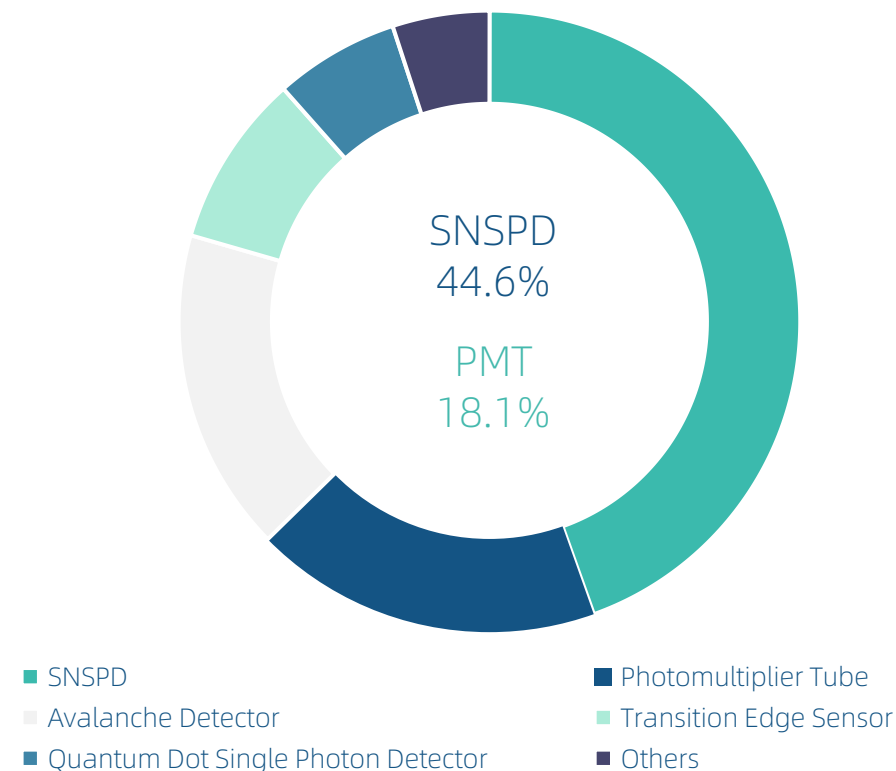
# Global Market Overview

## Global Market Size Forecast ( in Million USD )



The market of SPD will worth \$986 million in 2023, it was estimated to grow to \$1269 million in 2026, resulting at a 6-year CAGR of 9.43%.

## Market Share – by Region ( 2023E )

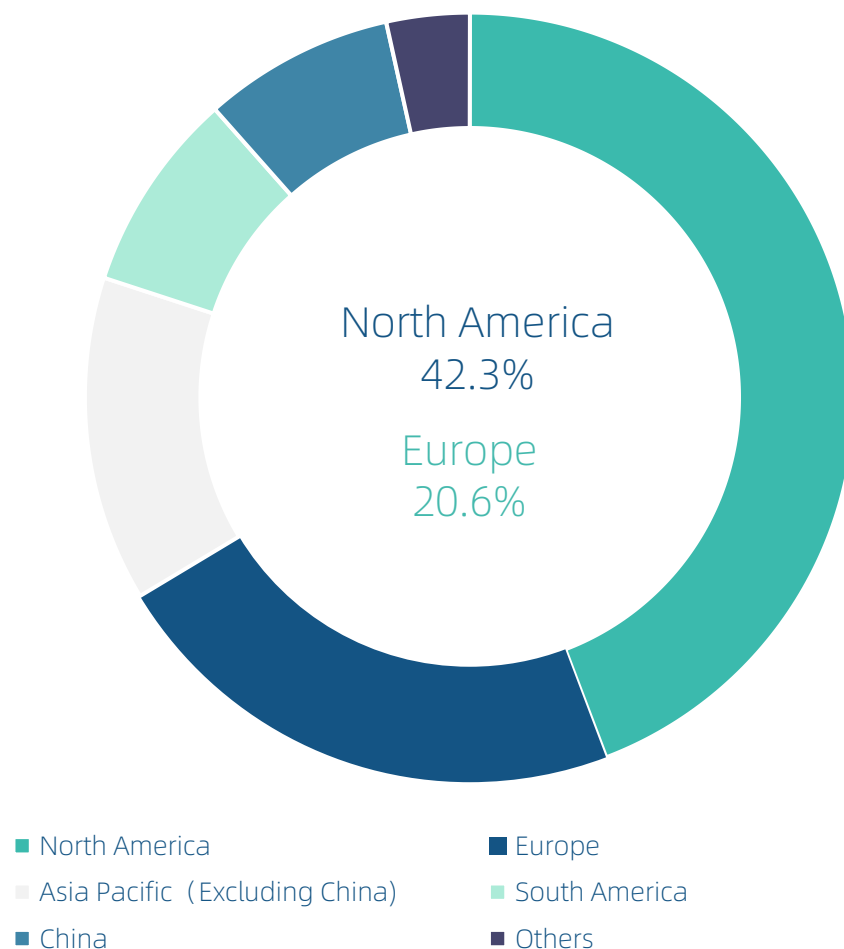


The market size of SPD in 2023 mainly comes from SNSPD, PMT and SPAD, with market shares of 44.6%, 18.1% and 16.8% respectively.



# Global Market Overview

## Market Share – by Region ( 2023E )

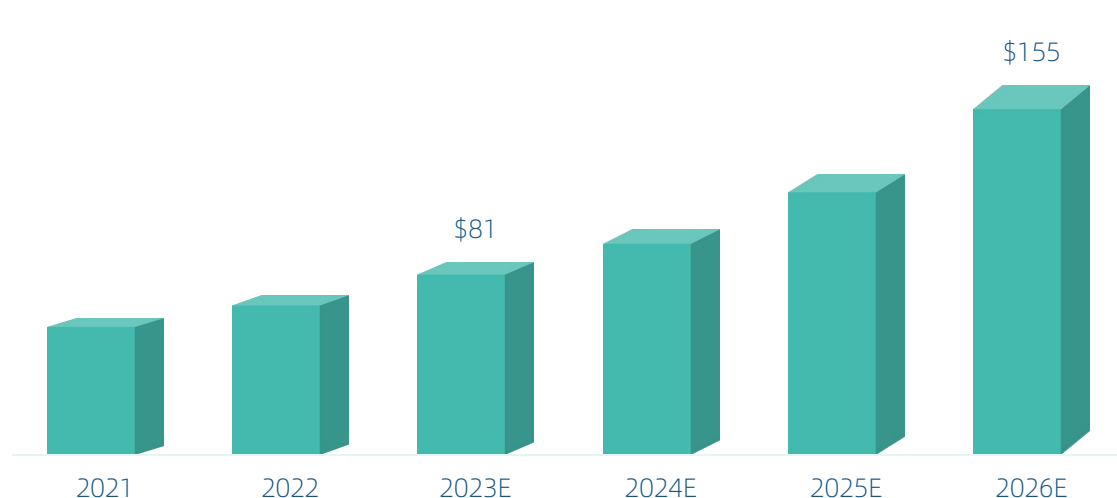


North America is an important market for single photon detectors, mainly driven by quantum information technology and laser radar technology. There are some leading manufacturers of single photon detectors in North America, such as Thorlabs, as well as research institutions and government departments such as the National Institute of Standards and Technology (NIST) and NASA. It is expected that the market share of single photon detectors in North America will reach **42.3%** by 2023.

Asia is a rapidly growing market for single photon detectors, mainly driven by investment and innovation in quantum information technology, laser radar technology, and biomedical fields by countries such as China, Japan, South Korea etc. It is expected that the market share of single photon detectors in Asia will reach **19.8%** by 2023.

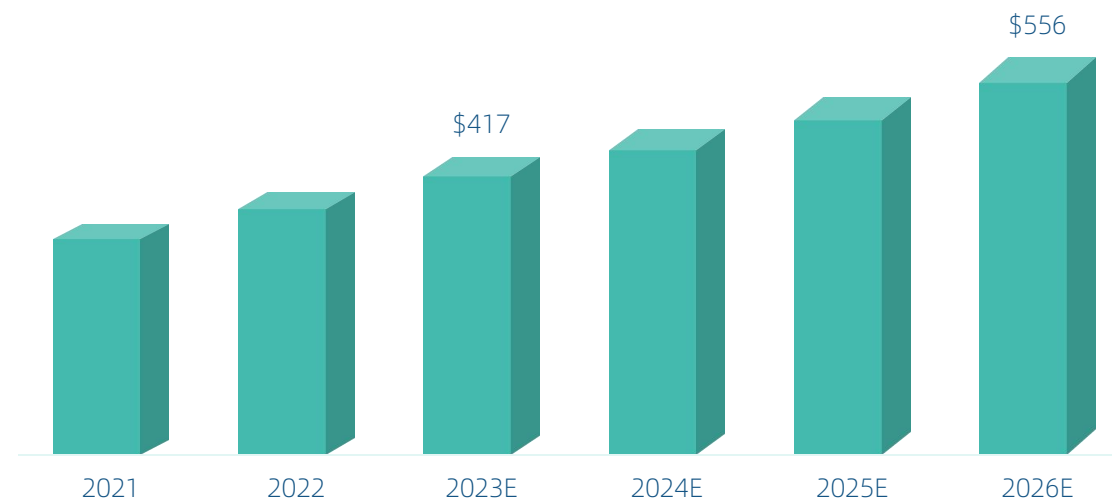
# Global Market Overview

## Market Size Forecast - China ( in Million USD )



The market of SPD in **China** was worth \$67 million in 2022, it was estimated to grow to \$155 million in 2026, resulting at a 6-year CAGR of 18.15%.

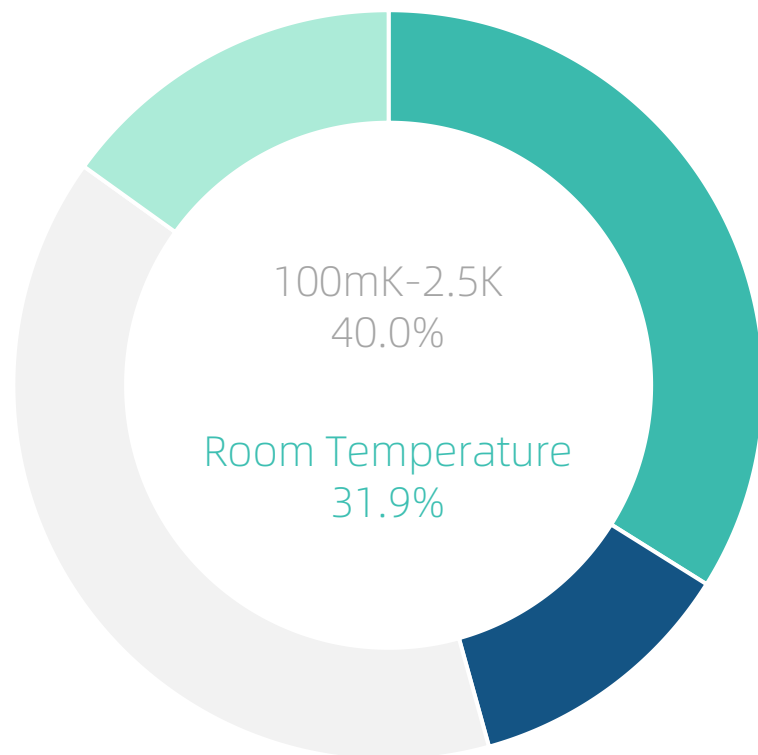
## Market Size Forecast - North America ( in Million USD )



The **North America** market was the Top largest segment, it was worth \$368 million in 2022 and is estimated to increase to \$556 million in 2026, with a 6-year CAGR of 9.53%.

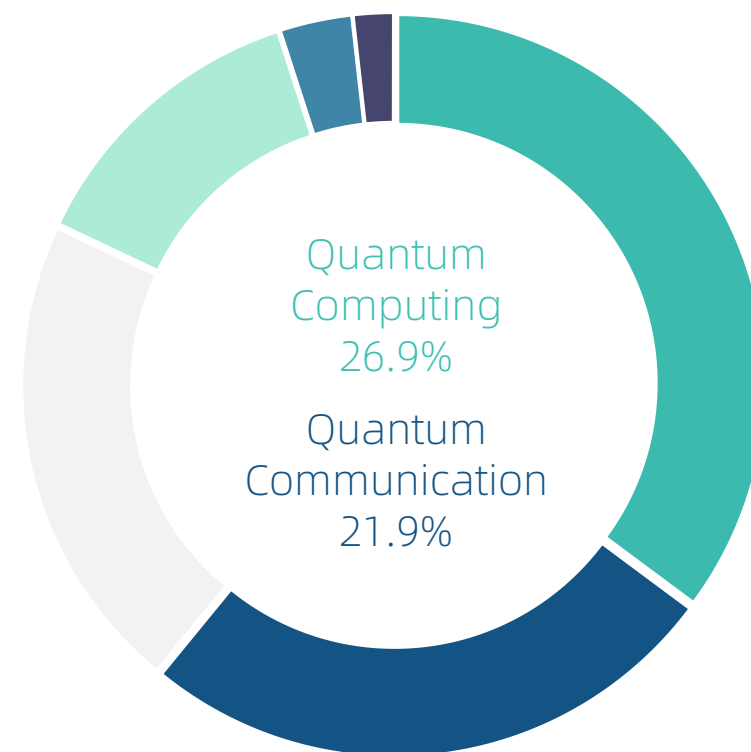
# Size of Segmented Market

Global SPD Market Size by Temperature  
( 2023E )



■ Room Temperature ■ 2.5K-Room Temperature ■ 100mK-2.5K ■ Below 100mK

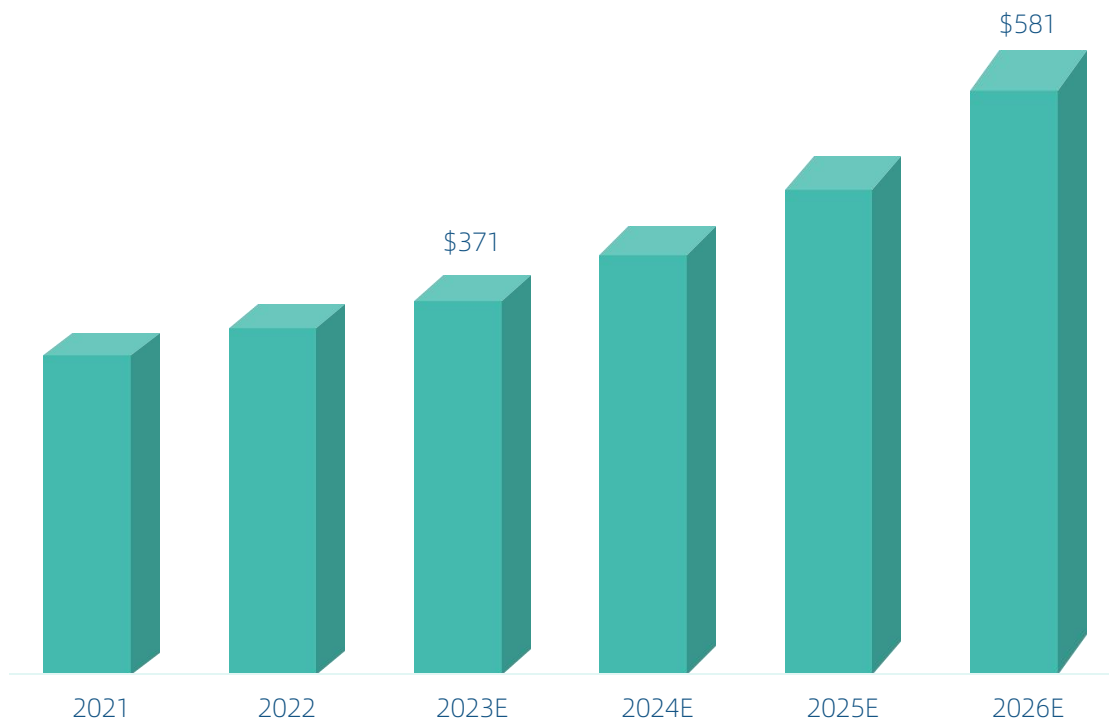
Global SPD Market Size by Application  
( 2023E )



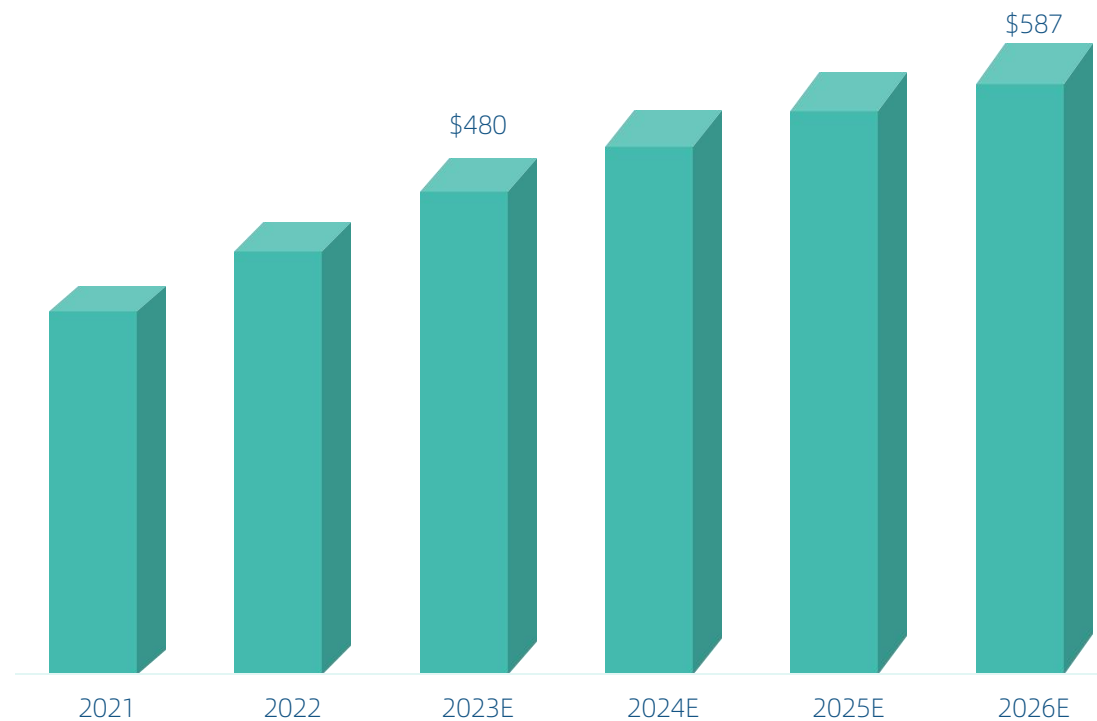
■ Quantum Computing ■ Quantum Communication ■ Biomedical  
■ Optical Computing ■ LiDAR ■ Other Applications

# Market Size of SPD by Type

## Semiconductor SPD Market Size Forecast ( in Million USD )

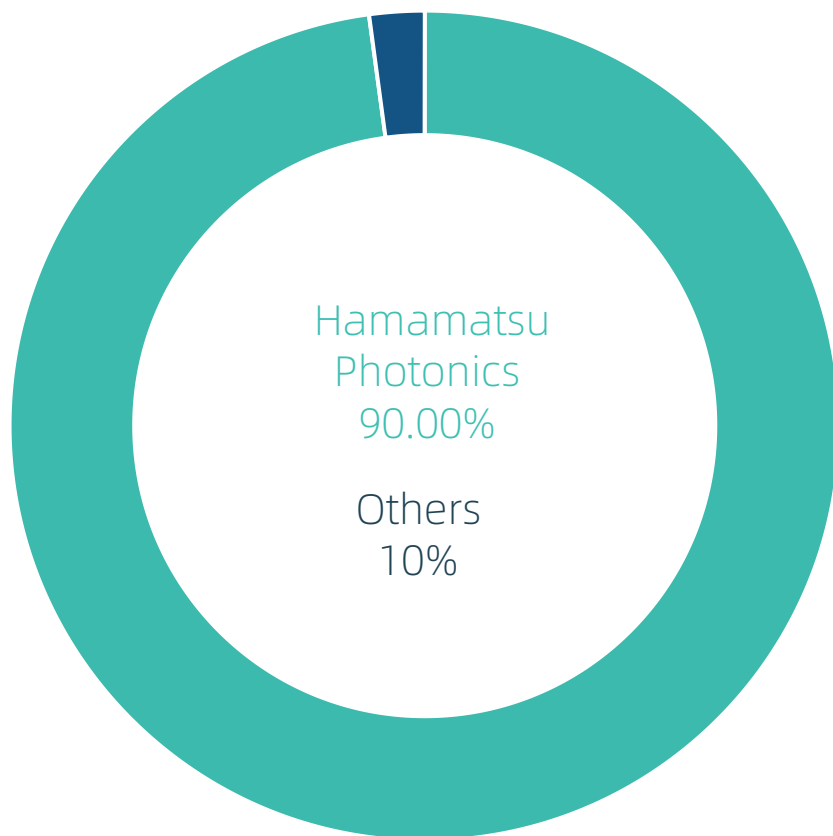


## Superconductor SPD Market Size Forecast ( in Million USD )



# Competitive Landscape

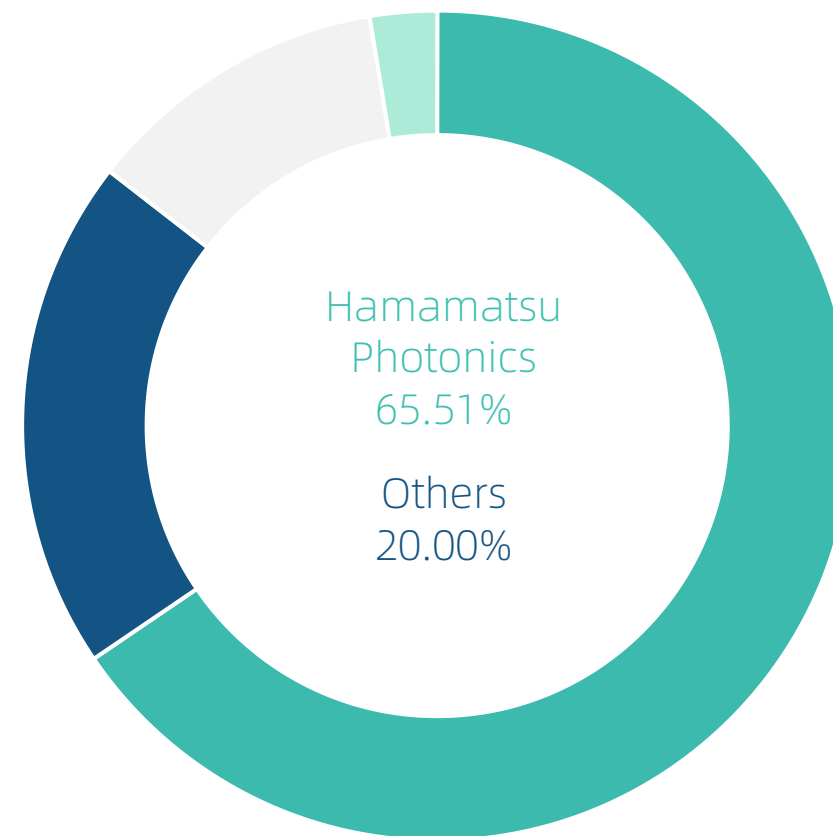
PMT Revenue Share by Vendor  
( 2023E )



■ Hamamatsu Photonics

■ Others

SPAD Revenue Share by Vendor  
( 2023E )



■ Hamamatsu Photonics

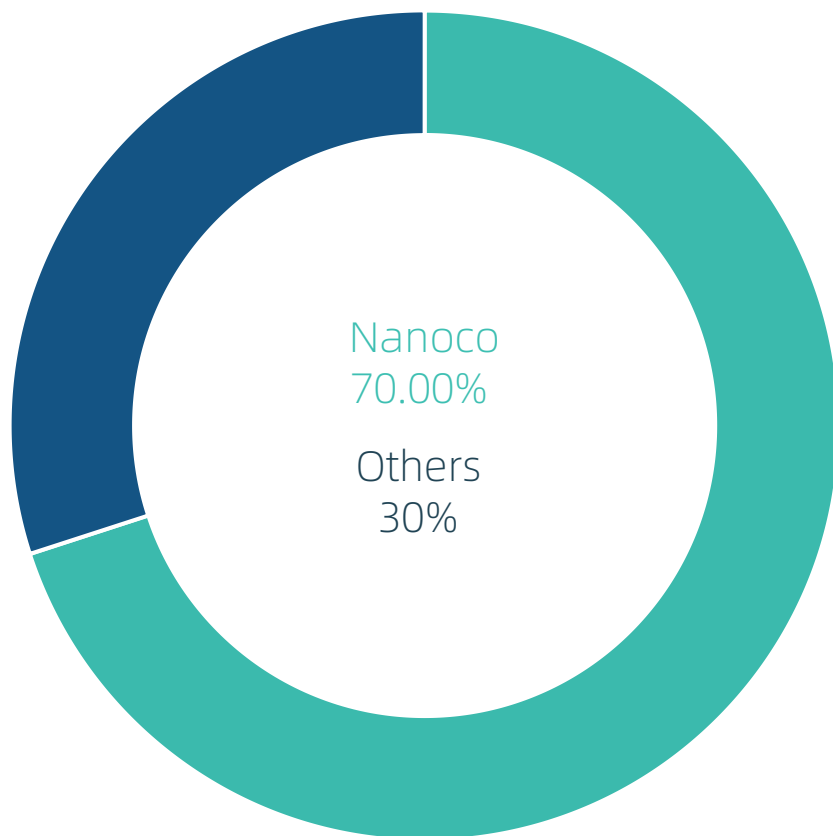
■ Others

■ LUNA

■ First Sensor

# Competitive Landscape

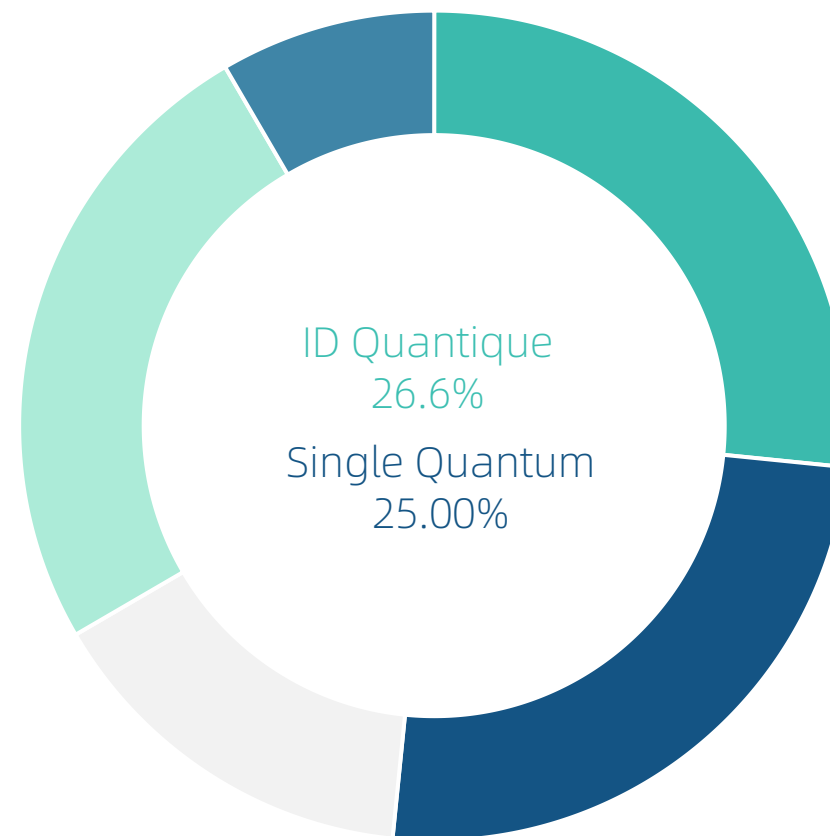
QT-SPD Revenue Share by Vendor  
( 2023E )



■ Nanoco

■ Others

SPAD Revenue Share by Vendor  
( 2023E )



■ ID Quantique

■ Single Quantum

■ Photon Spot

■ Others

■ Photon Technology



# Market Driver Factor -Technological Advancement

**SNSPD** technology advancements include improving the quality and uniformity of nanowire manufacturing, increasing quantity and arrangement, optimizing geometric shape and size, improving readout circuits and signal processing to improve detection efficiency, speed, bandwidth, sensitivity and other performance indicators.

**QD-SPD** technology advancements include improving the quality and uniformity of quantum dots, increasing their quantity and density, optimizing material structure, improving excitation and readout methods to improve detection efficiency, stability reliability and other performance indicators. These technological advancements have enabled QD-SPDs to effectively detect low-intensity signals from biological samples or other sources in medical imaging.

**TES** technology advancements mainly involve improving the quality and uniformity of superconducting films; increasing their area and thickness; optimizing material composition and structure; enhancing cooling systems for improved detection efficiency noise resolution among other performance indicators. These technological advancements have enabled TES-SPDs to effectively detect distant or dark field signals in astronomical observations.

# Market Driver Factor -Market Demand

**Quantum information and communication:** Quantum information and communication is an emerging field that utilizes the principles of quantum mechanics for information processing and transmission, with advantages such as ultra-high speed, ultra-high security, and ultra-high capacity. Single photon detectors are one of the core components of quantum information and communication, which can achieve precise reading and operation of quantum bits (qubits), thereby realizing functions such as quantum computing, quantum key distribution, and quantum networks. With the development of quantum information and communication technology, the market demand for single photon detectors will also increase.

**Medical imaging and biological detection:** Medical imaging and biological detection refer to the use of optical methods to image or analyze human or biological samples, with advantages such as non-invasiveness, high resolution, high sensitivity etc. Single photon detectors can be used to effectively detect low-intensity signals or dark-field signals in order to improve the quality and efficiency of medical imaging and biological detection. With advances in medical imaging and biological detection technology, there will also be an increasing market demand for single photon detectors.

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## Global SPD Market Research Report 2021-2026E

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