LASER COMPONENTS

Low light level detection with APDs

DETECTORS

LASERS

FIBER OPTICS

MEASUREMENT TECHNOLOGY

LASER-ACCESSORIES

OPTICS

Low light level detection with APDs

Outline

- Company background
- APD and SPAD technology
- Applications
- Outlook

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PRODUCT-PORTFOLIO

In-house Production | Detectors | Lasers | Measure-ment Devices | Fiber Optics | Optics | Laser Accessories

Laser Optics
VCSEL
Couplers/WDMs
UV Detectors
IR Laseroptics
Fiber Tools
Laser Diodes
Laser Power Measurement
IR Detectors
Optical Fibers
E/O Components
Position-sensitive Detectors
Laser Optics
Viewers
Photoncounters
Laser Safety
Optical Filters
Avalanche Photodiodes
Laser-Energy Measurement
Fiber Assemblies
Optical Switches
NIR Detectors
Conversion Screens
cw Laser Diodes
Laserrods & Crystals
Laser Alignment Systems
Pulsed Laser Diodes
Pyrodetectors
Laser Modules
Avalanche Photodiodes
Connectors
Electronics
Thermopiles
Beamanalysis
High Power Laser Diodes
Diffractive Optical Elements
IR Detectors

Low light level detection with APDs

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IR Detectors

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Optical Substrates
Fiber Optics
Photon Counter
Laser Modules
Detector Modules
Electronics

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Production facility for
Pulsed Laser Diodes

Low light level detection with APDs

Laser Components

Avalanche Photodiodes (APD)

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Single Photon Avalanche Diodes (SPAD)

Low light level detection with APDs

Laser Components GmbH

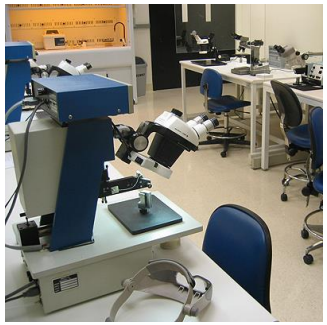
- Vision: Development, production and distribution of custom laser-based and optoelectronic components

- Established in 1982
- Located in Olching, Germany
- ISO 9001:2000 certified

- Production of PLD and APD electronics, Photon Counting Modules, Laser Optics, Laser Modules

Low light level detection with APDs

LC Detector Group, Inc.



- Vision: Produce high performance avalanche photodiodes and subsystems meeting and exceeding market expectations

- Established in 2004
- Located in Tempe, AZ
- ISO certified

- Production of both Si and InGaAs avalanche photodiodes, hybrids

Low light level detection with APDs

- Company background
- APD and SPAD technology
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Low light level detection with APDs

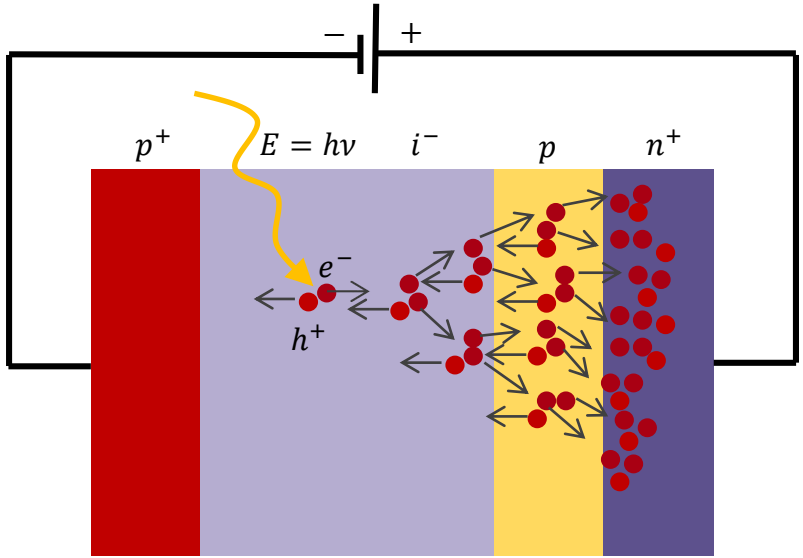
Technologies

- Photomultiplier
- PMT-APD-Hybrid
- Si-PM (APD and SPAD Arrays)
- (Single Photon) Avalanche Diode (APD, SPAD)
- EMCCD, sCMOS, CCD
- Superconducting Nanowires (SNSPD)

Low light level detection with APDs

APD / SPAD

- APD: Linear mode, Gain: $10^2 - 10^3$
- SPAD: Geiger mode „Gain“: $10^6 - 10^8$

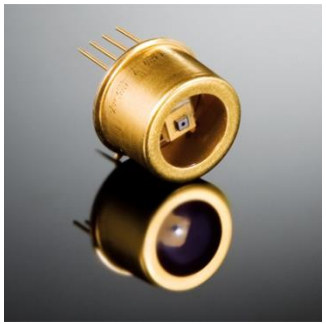


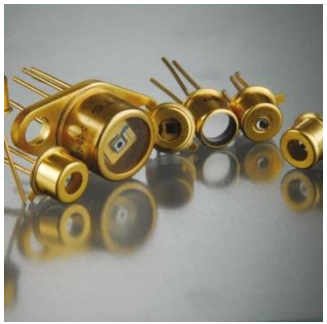
Low light level detection with APDs

Avalanche Photodiodes

Low light level detection with APDs

Avalanche Photodiodes

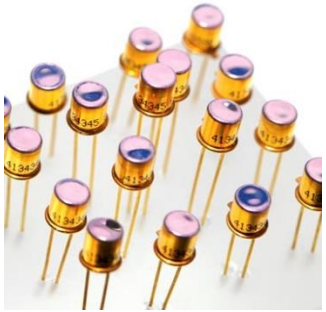




- SAE series
  - red-enhanced (peak at 650nm), NIR-enhanced (peak at 880nm)
  - 230µm and 500µm, dark current (M=100): 0.5 – 5 nA
- SAR series
  - with/without TEC, peak at 905nm
  - 500µm, dark current (M=100): 0.5 – 1.5 nA
- SAP series
  - linear mode and Geiger mode, with/without 1stg/2stg TEC
  - 500µm, dark current: 70 – 1000 (M=250) pA
- IAG series
  - Peak sensitivity at 1550nm; 80, 250 and 300µm

Low light level detection with APDs

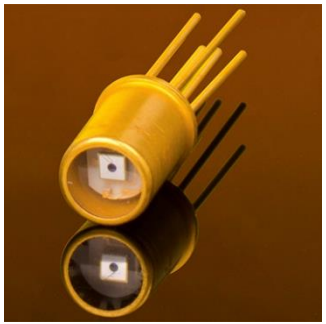
Avalanche Photodiodes



- With filters
  - SARF series: peak at 905nm, 500µm, 870 – 940nm range
- Fiber pigtail
- Large area
  - SAR series, 1500 and 3000µm
- UV enhanced
  - SUR series: 260 – 1000nm, 500µm
- Different packages available:
  - TO-46 (2 pin, 3 pin)
  - TO-37 (TEC)
  - TO-8 (TEC)
  - SMD

Low light level detection with APDs

APD Receiver



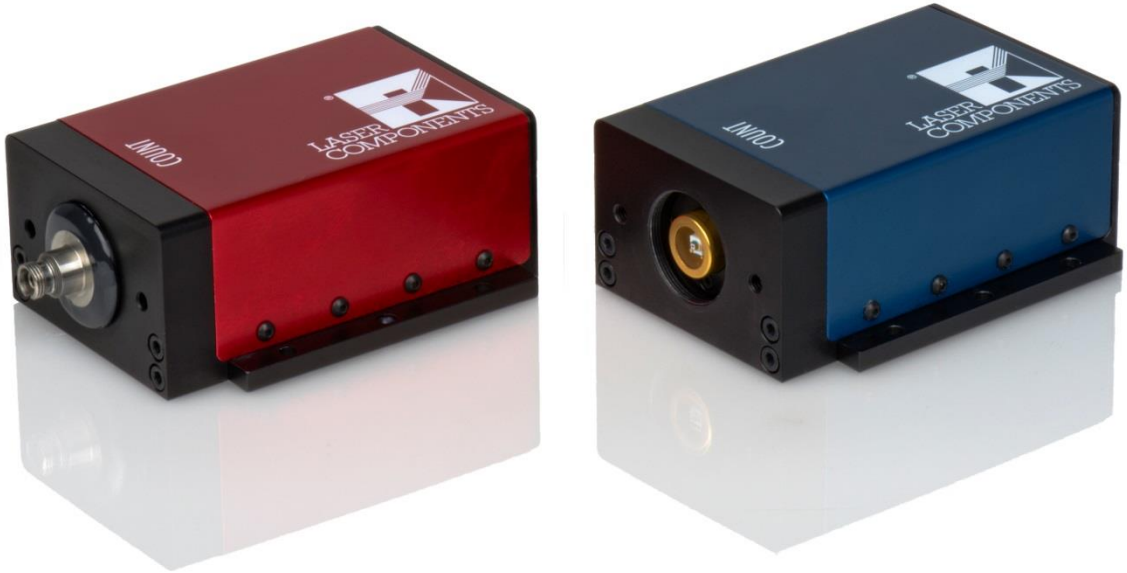
LASER COMPONENTS

APD with optimized preamplifier, APD-modules

- Si and InGaAs versions available
- H1 series
  - Bandwidths from DC to 25 MHz, TO-8 package
- H2/H3/H4/H5 series
  - Bandwidths from 10 kHz to 700 MHz, TO-46 package
- A-CUBE module

Low light level detection with APDs

COUNT®



Low light level detection with APDs

COUNT®

- VLoK Geiger mode silicon APD
- Built-in TEC → -10°C
- Active quenching electronics
- Gating function
- 12V DC voltage supply
- Optional FC/PC connector with AR-coated Grin lens

Low light level detection with APDs

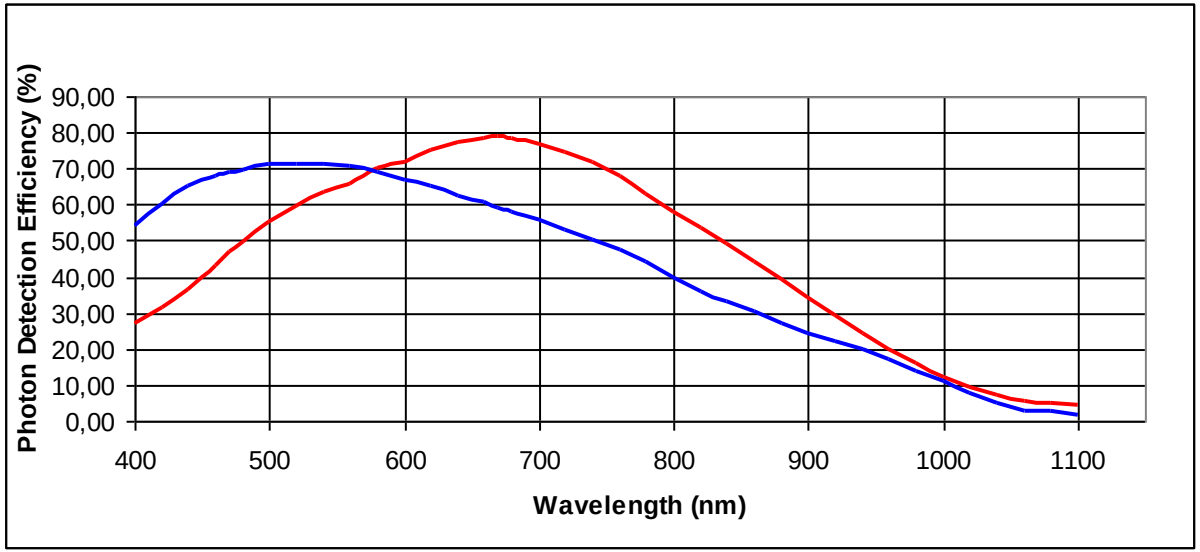
COUNT®

- DE > 70% at 670nm
- DCR < 10cps
- Afterpulsing < 0.5%
- Dead time: 42ns
- Gating function

- DE > 70% at 532nm
- DE > 55% at 405nm
- DCR < 10cps
- Afterpulsing < 0.5%
- Dead time: 42ns
- Gating function

Low light level detection with APDs

Detection Efficiency



Low light level detection with APDs

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Low light level detection with APDs

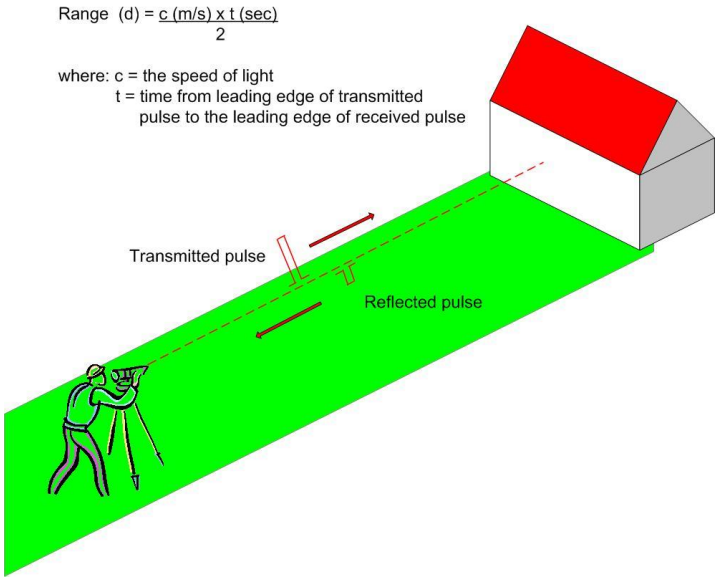
Applications

Low light level detection with APDs

Applications

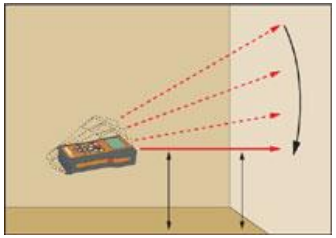
Distance Measurement

- Time of Flight
- Phase Modulation
- Absolute Interferometry
- Triangulation



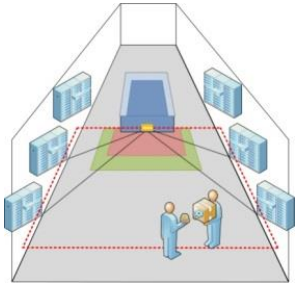
Low light level detection with APDs

Applications



Industrial Applications

- Surveying equipment
- Security barrier
- 3D Imaging and Profile Scanner
- Ceilometer
- Laser Distance Meter for construction

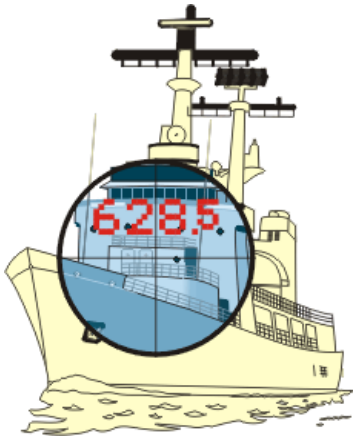


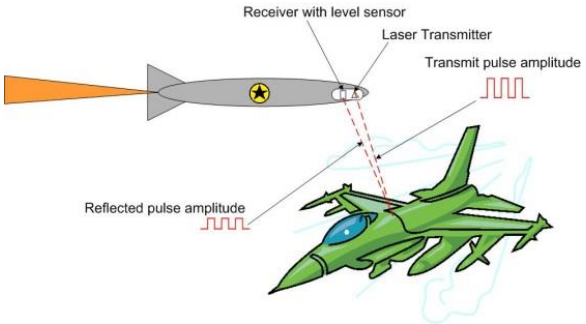
Low light level detection with APDs

Applications

Military

- Range Finding up to 10km
- „Friend or Foe“ identification
- Telemetry / Weapon Simulation
- Proximity Fuse



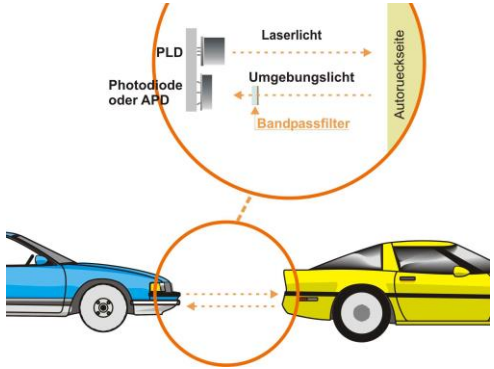


Low light level detection with APDs

Applications

Automotive

- ACC (Adaptive Cruise Control)
- Automated Toll Collection
- Speed Guns
- Traffic Control



Low light level detection with APDs

Applications

Commercial and Medical

- Rangefinder for Hunting, Golf…
- Speed guns for sports

- Laser induced accelerated healing
- Diagnostic ophthalmology

Low light level detection with APDs

Applications

Single Photon Counters are used for

- Particle sizing
- Confocal microscopy
- Time-resolved fluorescence detection
- Astronomy
- Quantum cryptography
- Spectroscopy

Low light level detection with APDs

Applications

Particle Sizing

- Dynamic light scattering / Photon Correlation Spectroscopy
- Doppler shift measurement on moving particles
- Particle diameter from <1 nm to > 1 µm

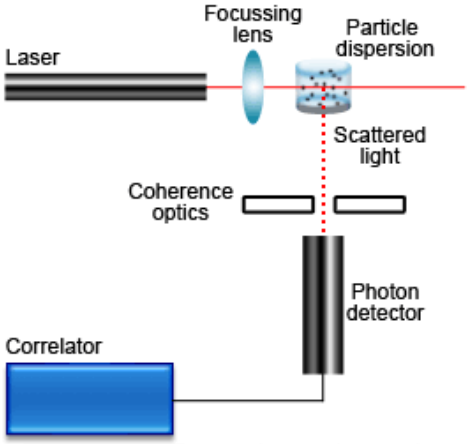


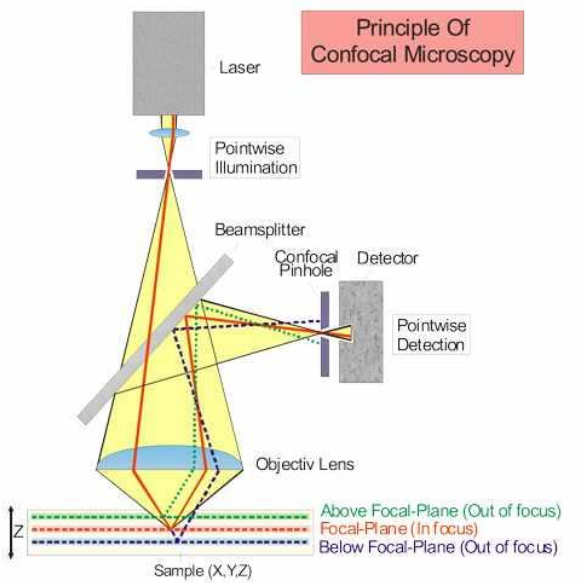
Figure 1: Schematic diagram of a conventional, 90° dynamic light scattering instrument.

Low light level detection with APDs

Applications

Confocal Microscopy

- Laser-induced fluorescence
- Point sensor principle
- Reduced depth-of-field = higher resolution

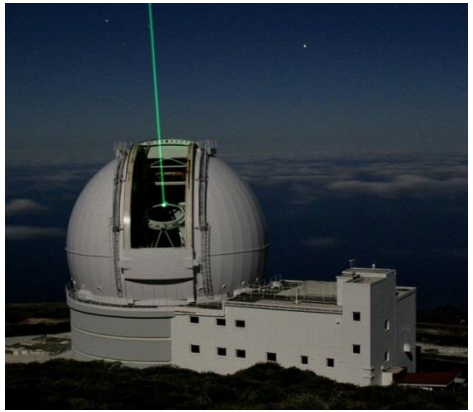


Low light level detection with APDs

Applications

Astronomy

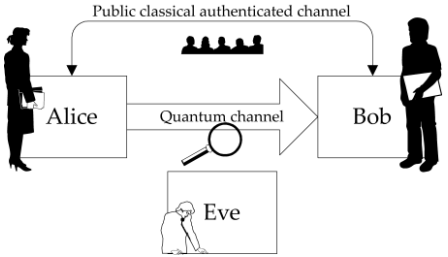
- Long-range LIDAR
- Adaptive telescope optics



Low light level detection with APDs

Applications

Quantum Cryptography



- Quantum key distribution – use of quantum communication to securely generate a key for two parties (Alice & Bob) to securely communicate
- Immune to eavesdropping – any third party attempt (Eve) will disrupt the quantum states of the photons

Outlook

- 10mm LARS series
- APD arrays
- Timing SPAD with 200-400ps jitter
- **Your product!**

Thank you for your attention!