

# LiDAR Technologies

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Applications and suitable components

EPIC Online Technology Meeting on LIDAR 2.1 Applications for 2021

# Advantages of Optical Distance Measurement

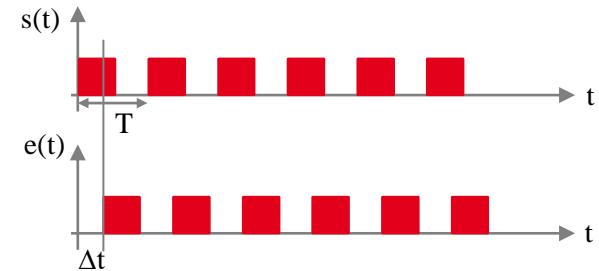
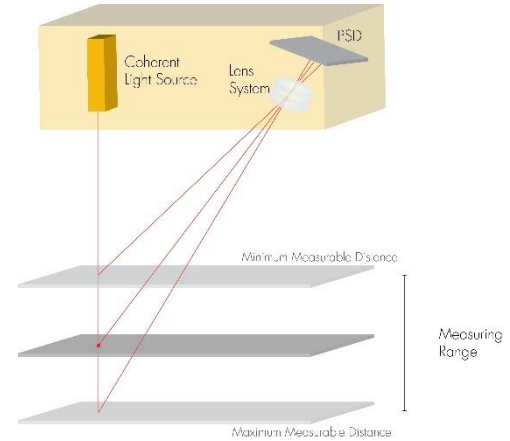
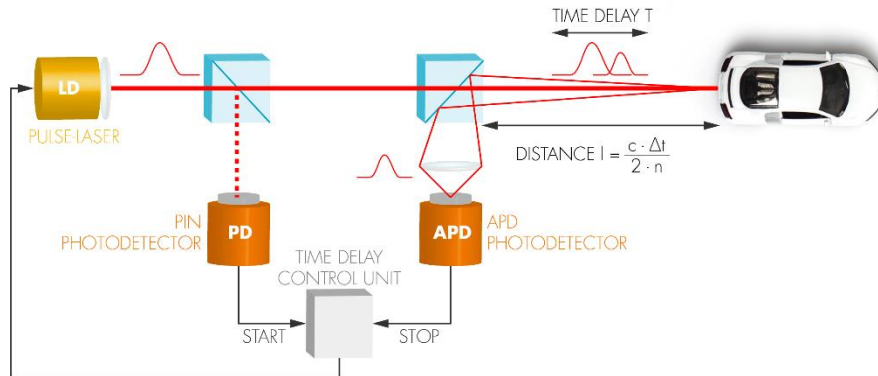
- Fast ( $c = 299\,792\,458$  m/s, d.h. 1 ns corresponds to ca. 30 cm)
- Contactless
- No wear and tear
- Different measuring ranges and measurement accuracy



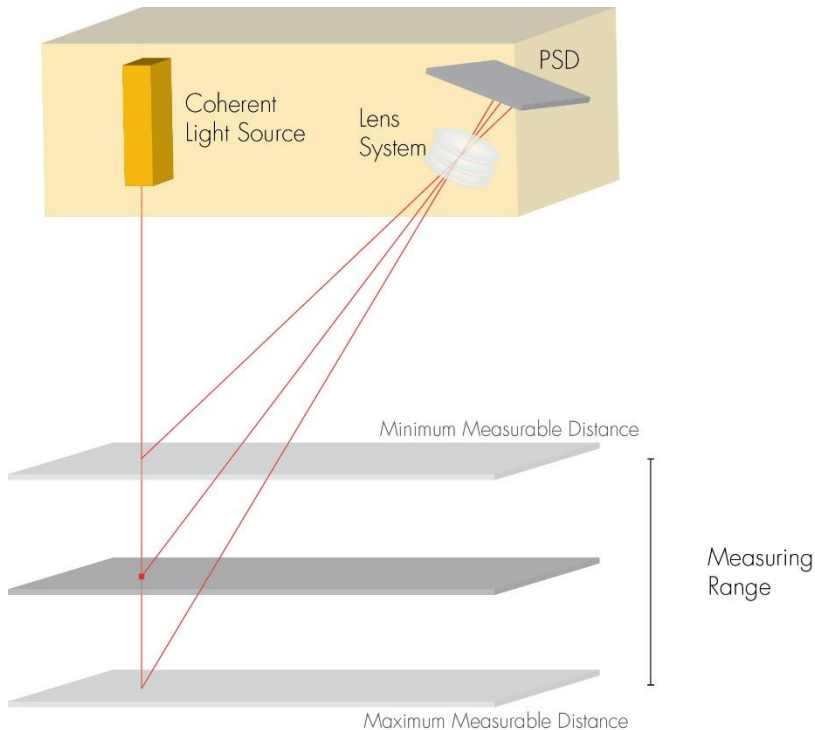
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# Variants of Optical Distance Measurement

- Triangulation
- Phaseshift
- Time-of-Flight (ToF)



# Measuring Principle of Triangulation



## Suitable Components

### Emitter:

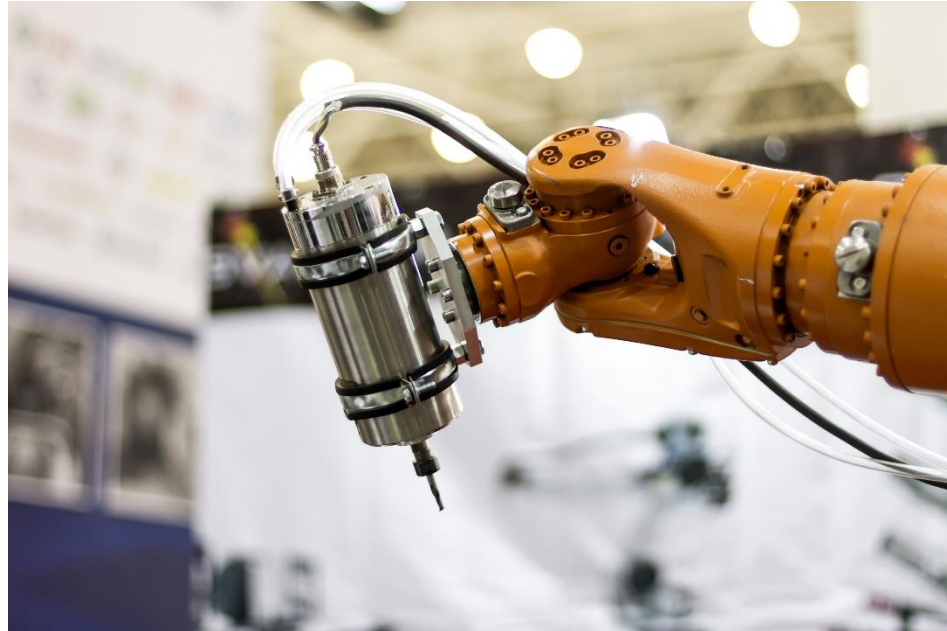
- LED, collimated laser diode, VCSEL

### Detector:

- PSD, Differential or Quadrant-Photodiode, CCD

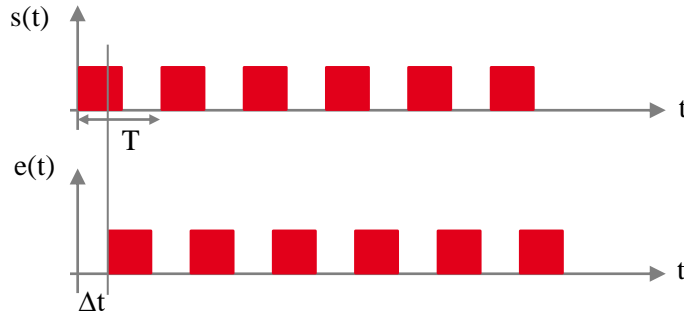
# Measuring Range, Accuracy, Properties

- Measuring range 1  $\mu\text{m}$  to max. 10 m, most 5-200 mm
- Accuracy of 0.01% possible (sub  $\mu\text{m}$ )
- Depending on the surface
- Inexpensive
- Robust



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# Measuring Principle of Phaseshift



The phase difference is obtained through the equation:

$$\phi = \frac{\Delta t}{T} * 2 \pi$$

Distance can be calculated by:

$$s_n = \frac{c * T}{4 \pi} (\phi + 2 \pi * n)$$

## Suitable Components

### Emitter:

- Laser diode, red / green / NIR

### Detector:

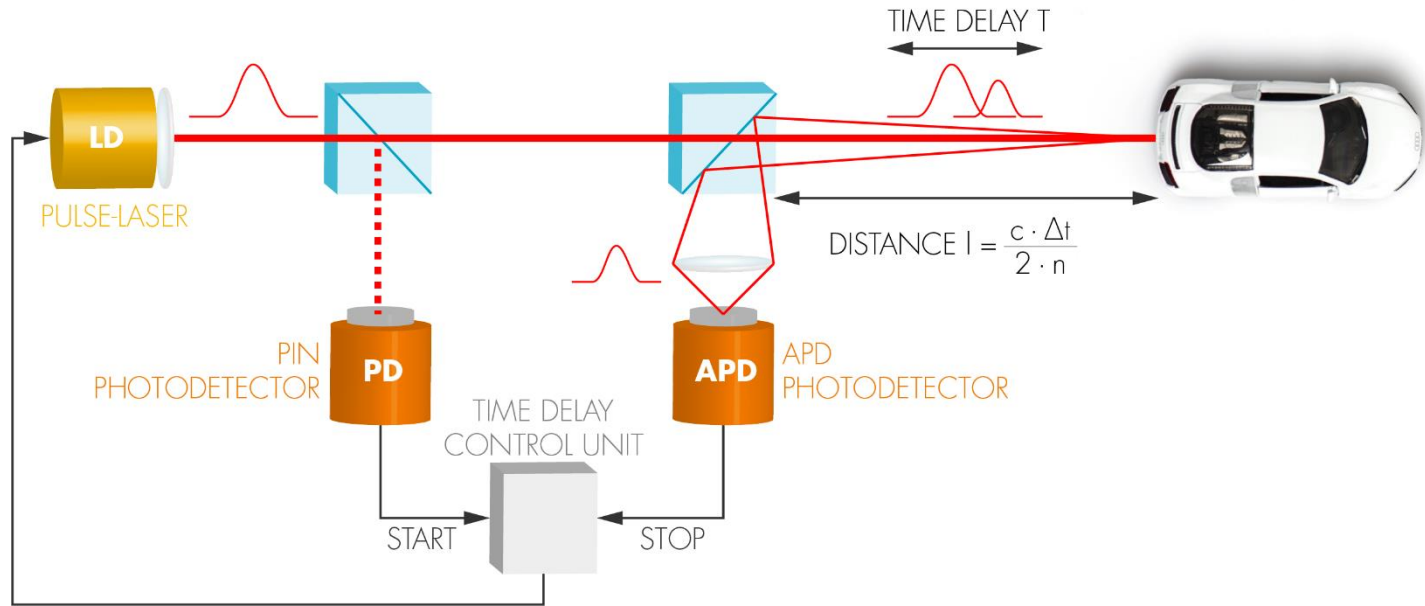
- Low cost Si-APD, PIN-Photodiode

# Measuring Range, Accuracy, Properties

- Measuring range few cm up to max. 200 m
- Accuracy: mm-range
- High frequency (bis 1 GHz)
- Production costs low



# Measuring Principle of TOF – Time of Flight





# Measuring Range, Accuracy, Properties

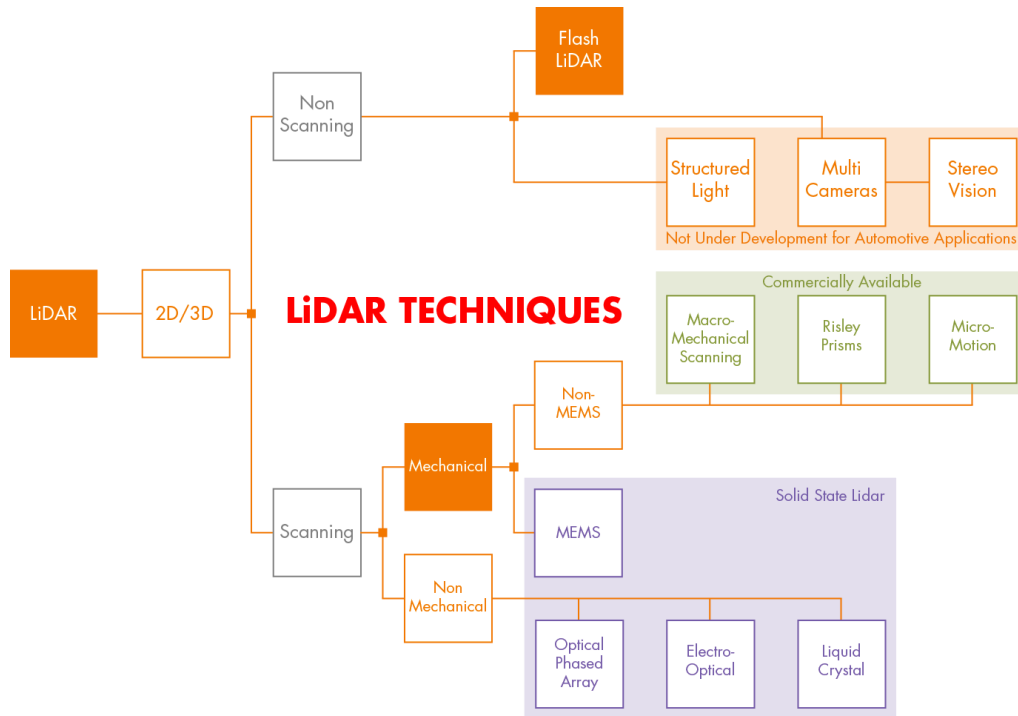
- Measuring range 1 m up to >> 10 km
- Accuracy: mm-range possible, usually m-range
- ns / ps sulses
- short reaction time



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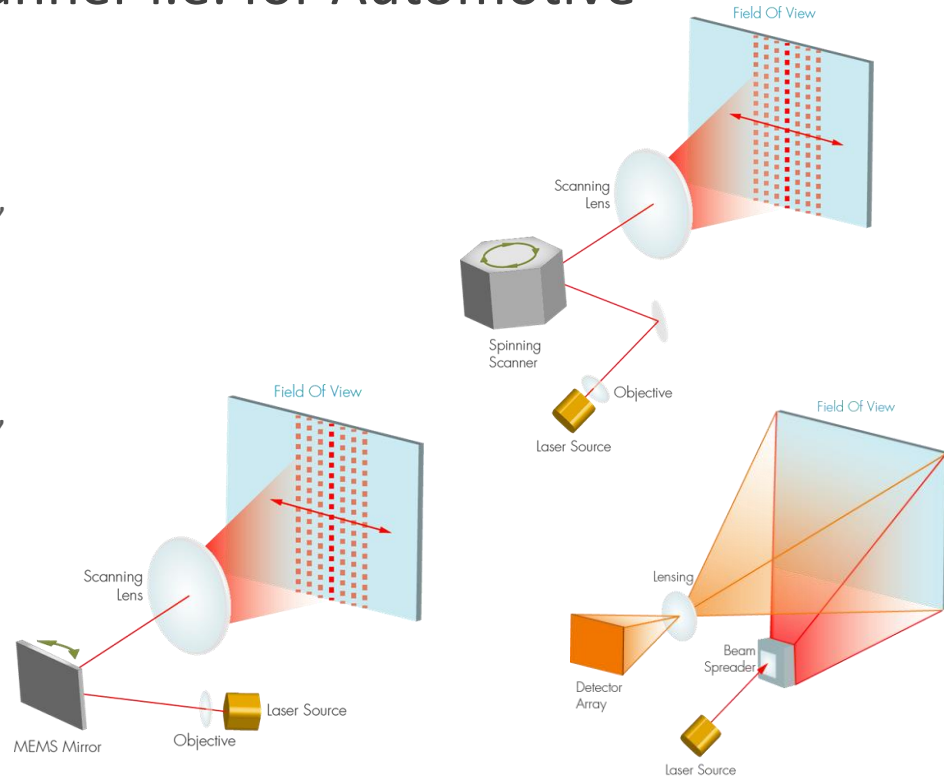
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# 2D / 3D Scanner



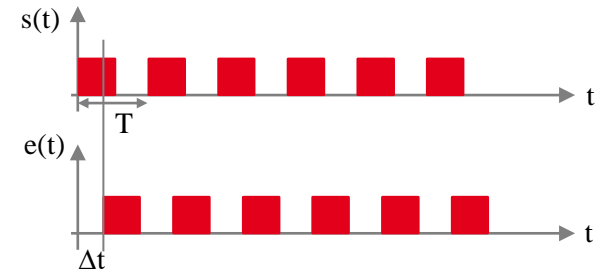
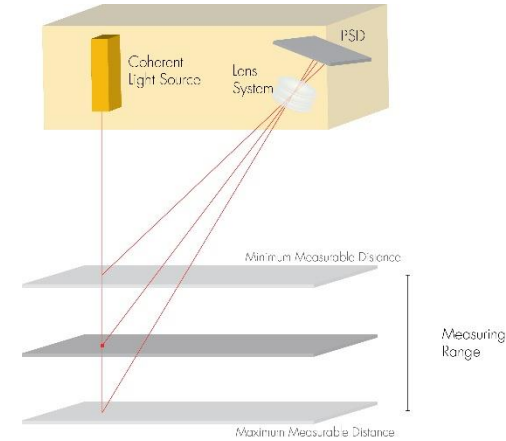
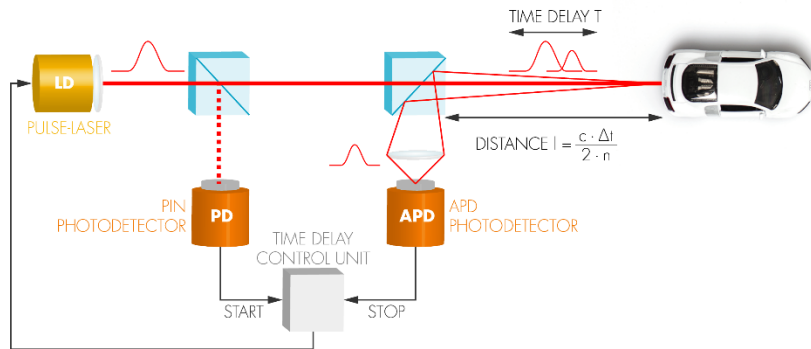
# Application: 3D Laser Scanner i.e. for Automotive

- 3D Laser Scanner
  - 905 nm PLDs (Arrays), QS-PLD (Quick Switch), Si-APDs (Arrays), Si-PM
- Solid State 3D Laser Scanner
  - 905 nm PLDs (Arrays), QS-PLD (Quick Switch), Si-APDs (Arrays), Si-PM
- Flash LiDAR
  - VCSELs, HPLD, SPADs, HD-SiPM



# Summary

- Triangulation
  - 1  $\mu\text{m}$  – 100 m, nm resolution possible
- Phaseshift
  - Frequency depending up to 200-300m, mm resolution, cheap
- Time-of-Flight
  - 1 m -  $\gg$  10 km, short reaction time, ns/ps pulses



# Your Contact



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