

SCANNING SOLID STATE LIDAR

9th Fraunhofer IMS Workshop CMOS Imaging
May 7th 2019
Duisburg

Michael Kiehn

Dokumentenklasse: Public

MICHAEL KIEHN



Michael Kiehn

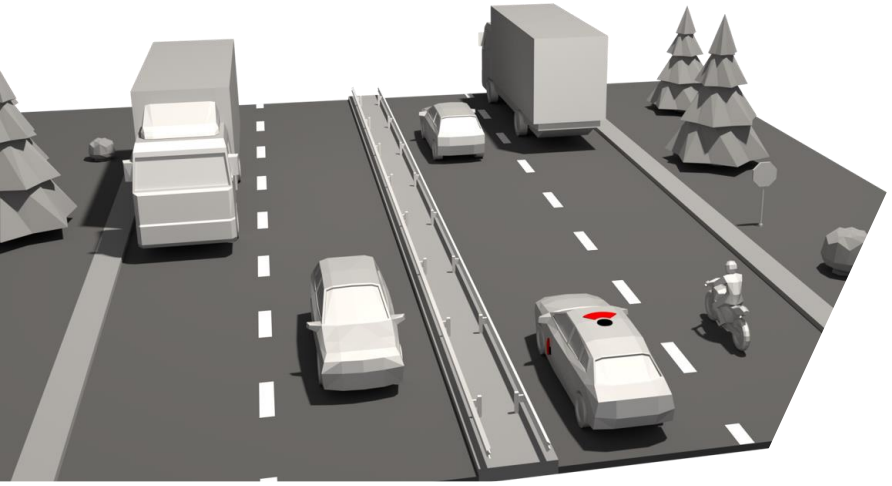
Working experience

1996-1998	Design Engineer Hardware and Firmware Ansari
1998-2003	Design Engineer Hardware and Firmware Ibeo Lasertechnik
2003-2009	Head of Sensor Development Ibeo Automobile Sensor
2010-present	Head of Sensor Development, Co-Founder and Share Holder Ibeo Automotive Systems

Scientific education

1992-1995	Dipl.-Ing. Electrical and Electronic Engineering University of Applied Science Hamburg
1995-1996	BEng Hons in Electrical and Electronic Engineering University of Portsmouth (UK)

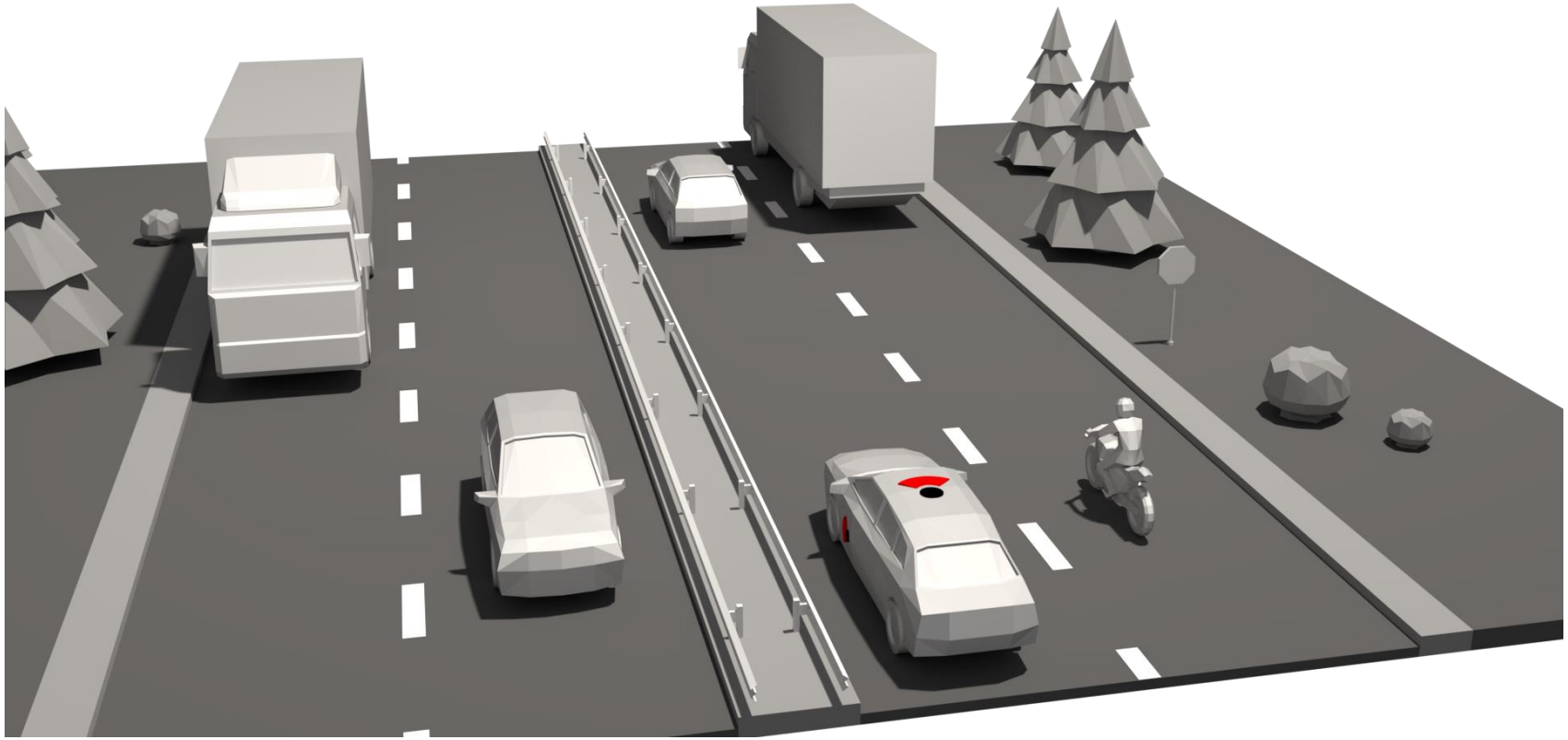
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WHY LIDAR

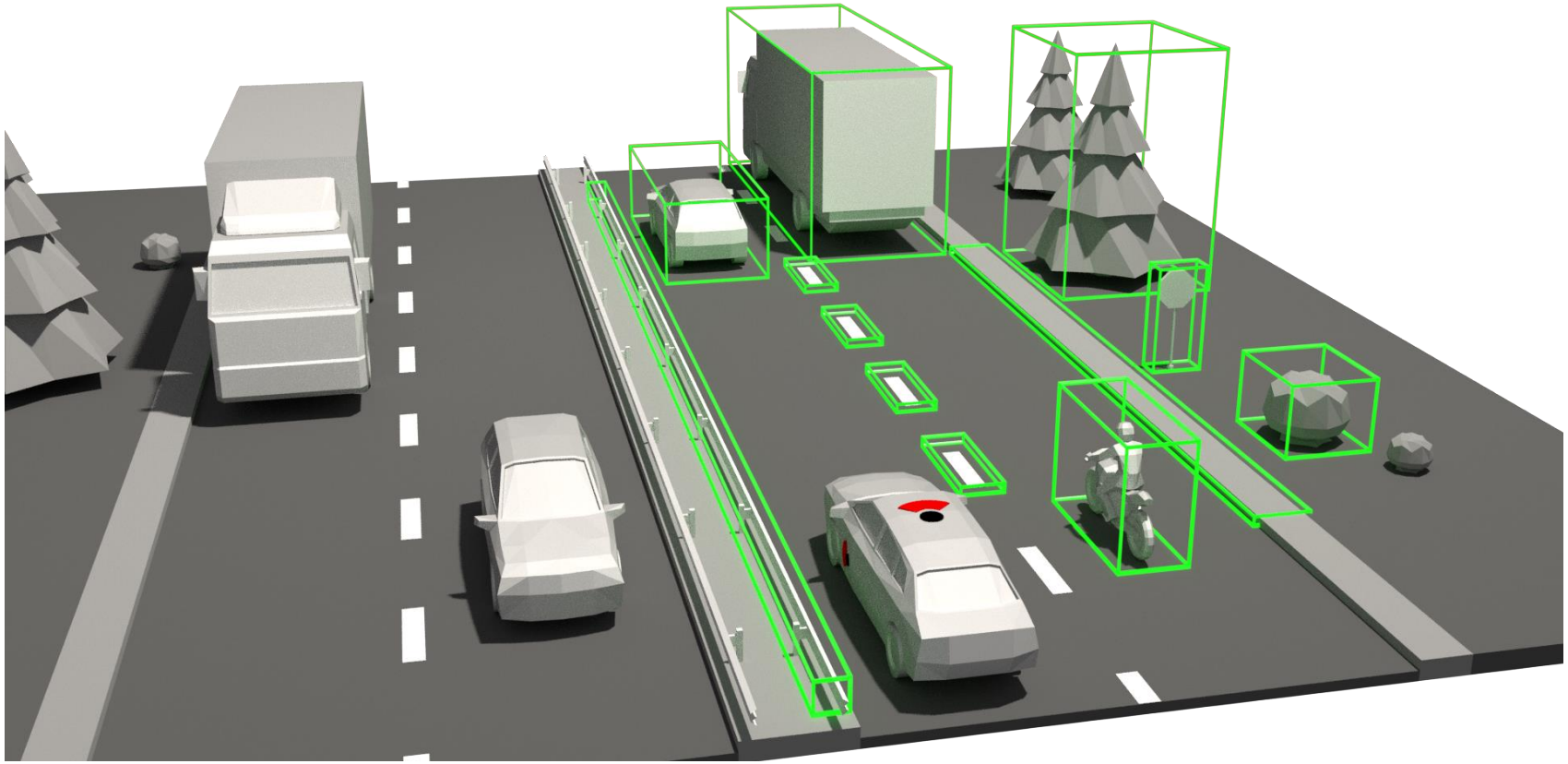
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HIGHLY AUTOMATED DRIVING



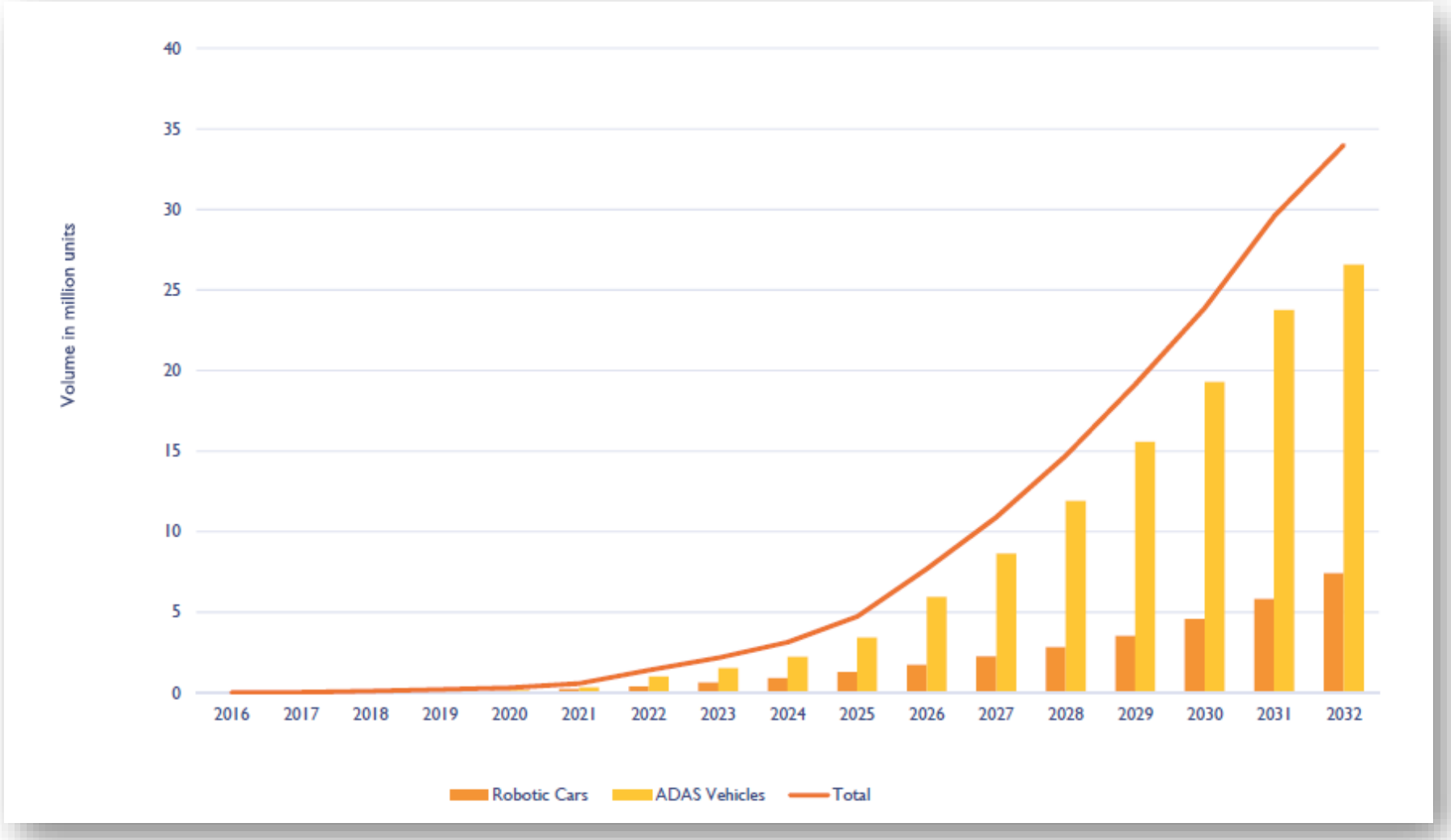
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HIGHLY AUTOMATED DRIVING



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AUTOMOTIVE LIDAR SHIPMENT



Yole Development: The Automotive LiDAR Market, April 2018



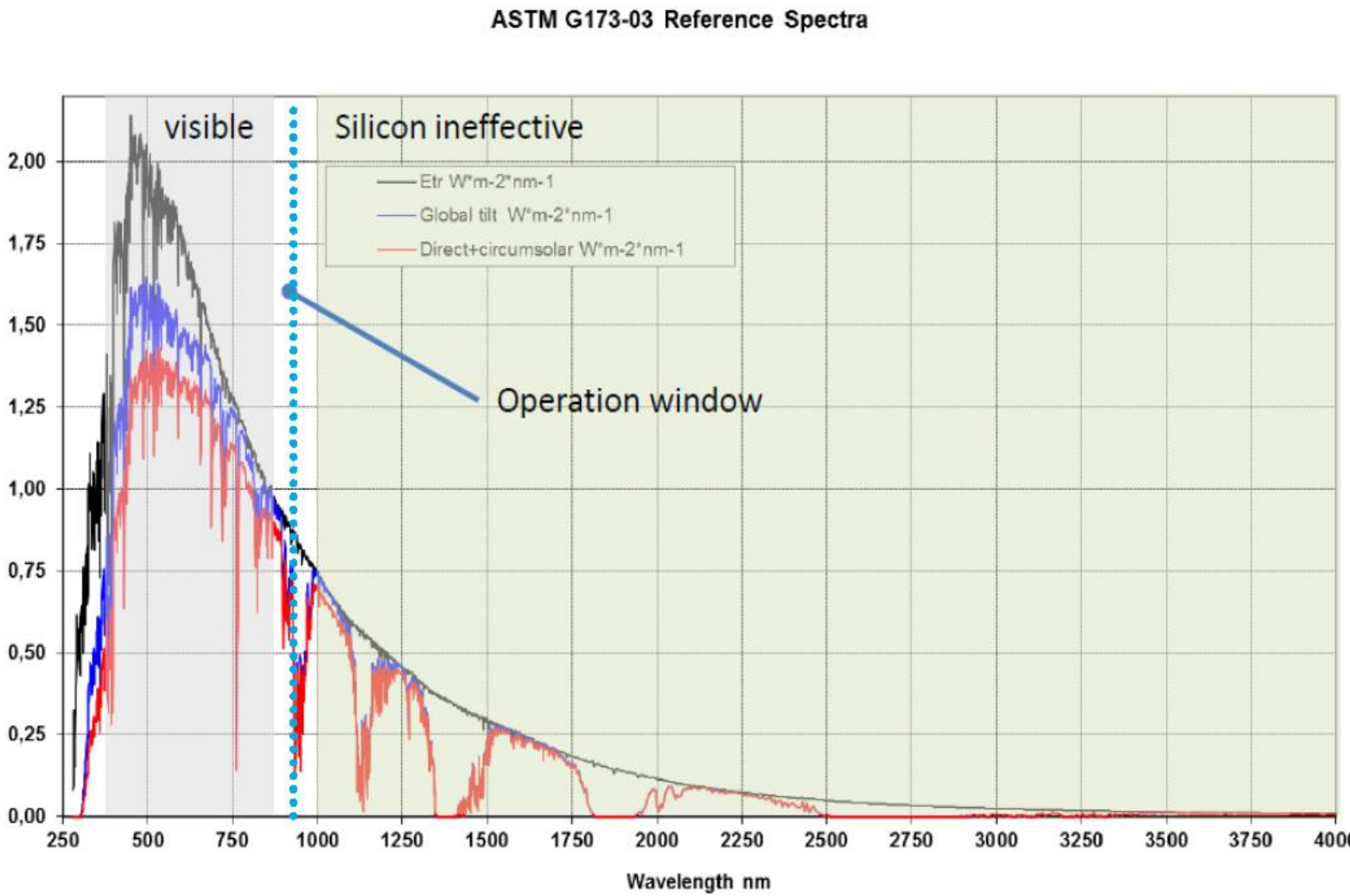
HOW CONCEPTS DIFFER

- Working wavelength
- How Field of View is achieved
- Measurement method

WAVELENGTH

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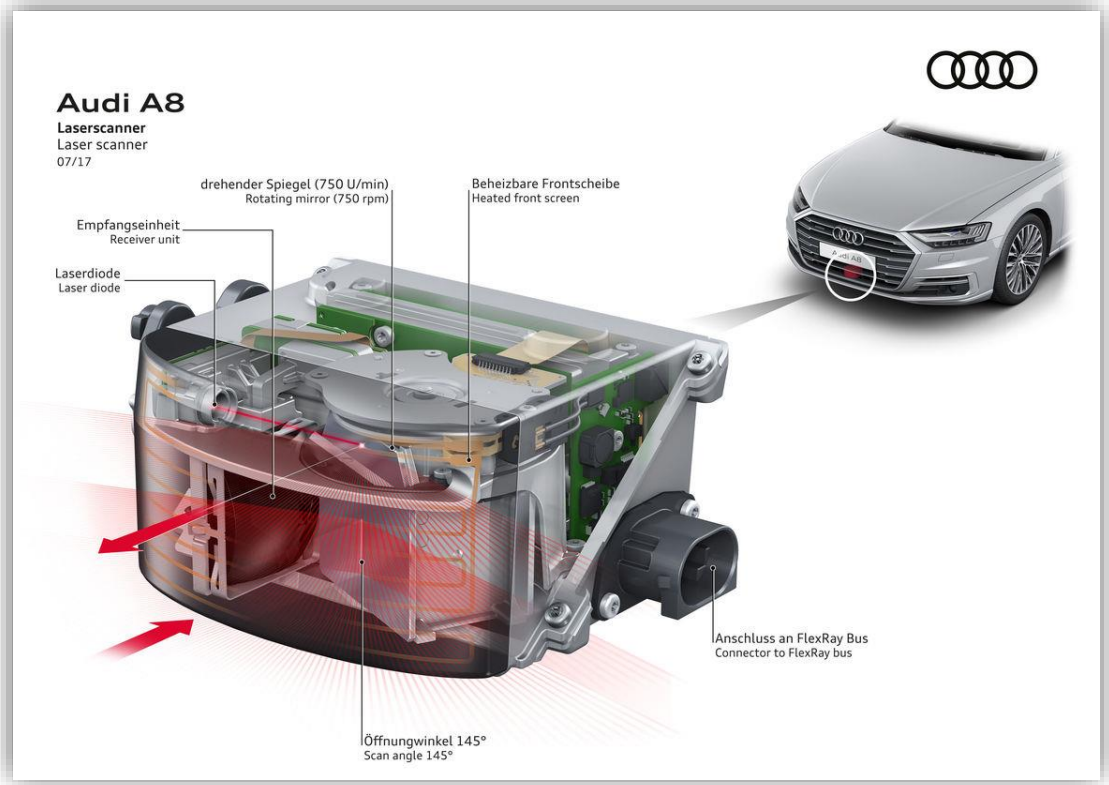
TYPICAL WAVELENGHTS FOR LIDAR

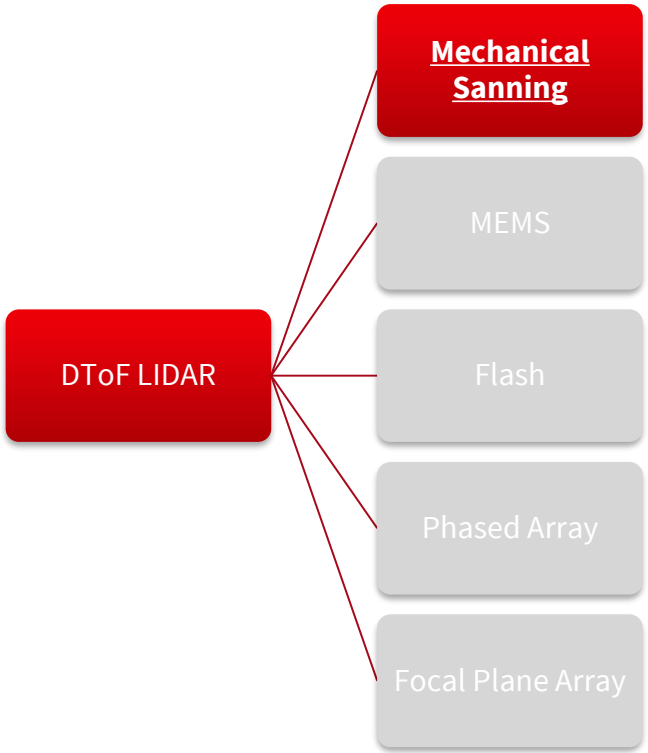


- ~905 nm
  - silicon-based detectors
  - good transmission in atmosphere
  - 850nm is partly visible
- ~1500 nm
  - best eye-safety
  - lower solar background
  - IR (non-silicon) photo detectors

FIELD OF VIEW

LIDAR CURRENT STATE | MECHANICAL SCANNING



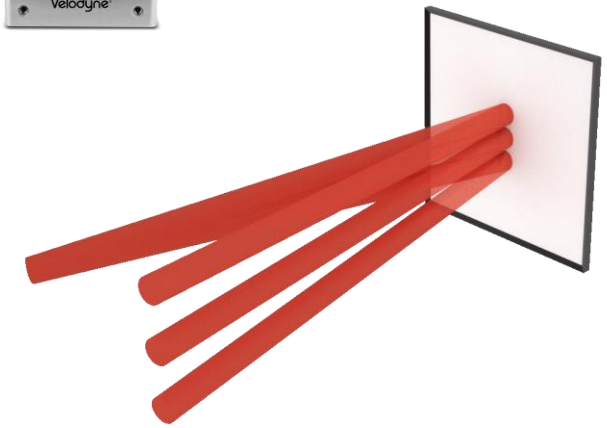


Source: Audi press information, https://www.audi-mediacenter.com/de/audi-a8-50

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LIDAR CURRENT STATE | MECHANICAL SCANNING



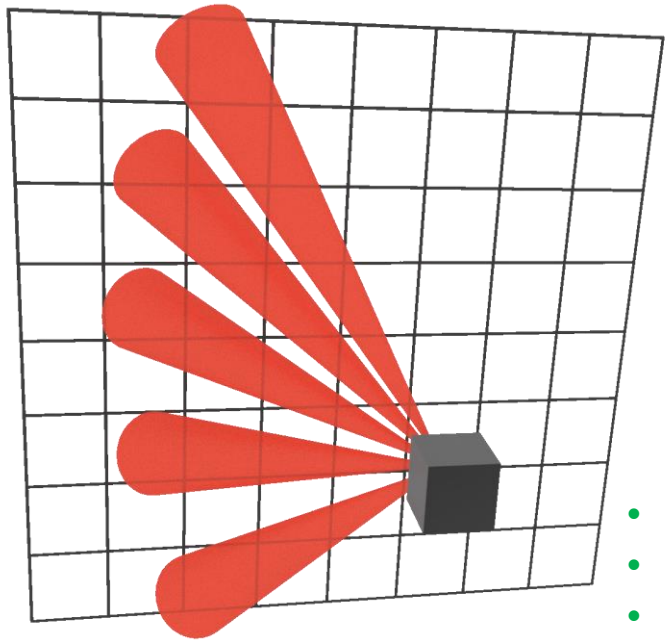


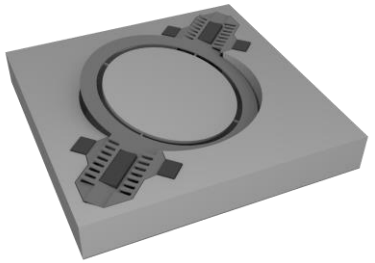


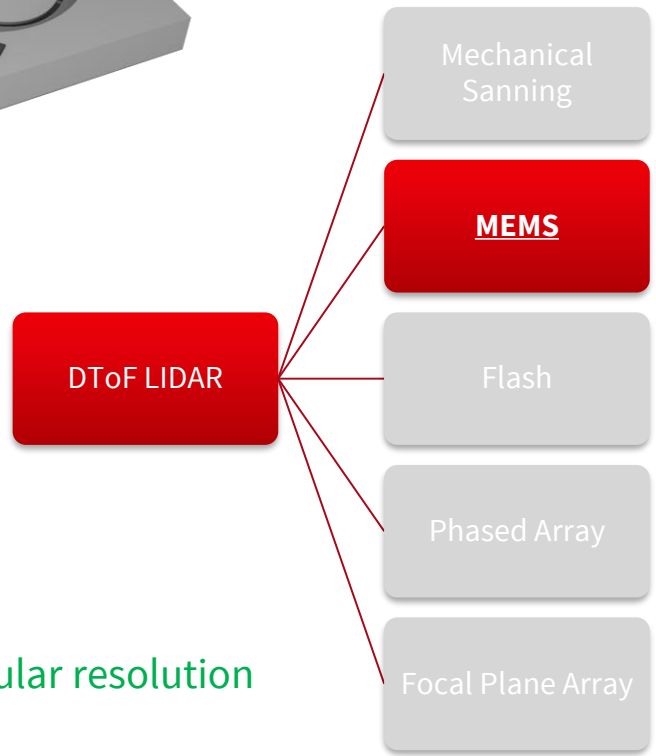
- Potential large hor. field of view
- Good SNR
- Flexible hor. angular resolution

- Robustness
- Cost
- Size

SOLID-STATE LIDAR | MEMS





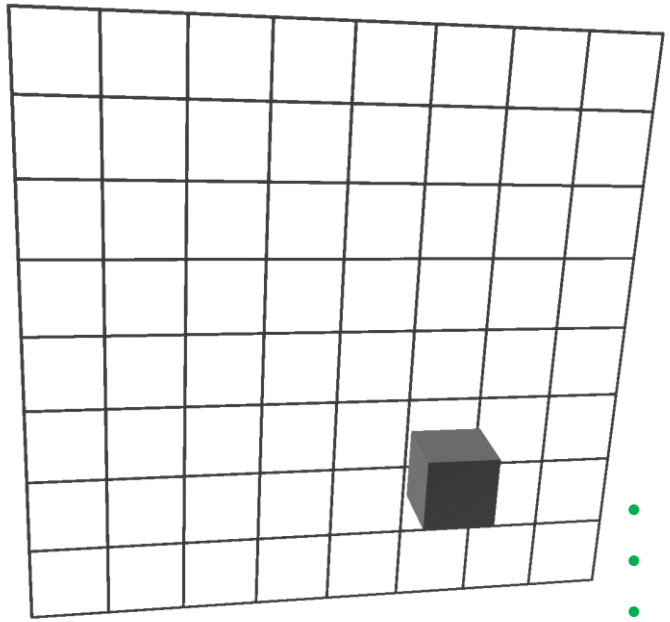


- Small size
- Cost
- Flexible hor. angular resolution

- Bad SNR
- Limited hor. field of view
- Not compatible with SPADs

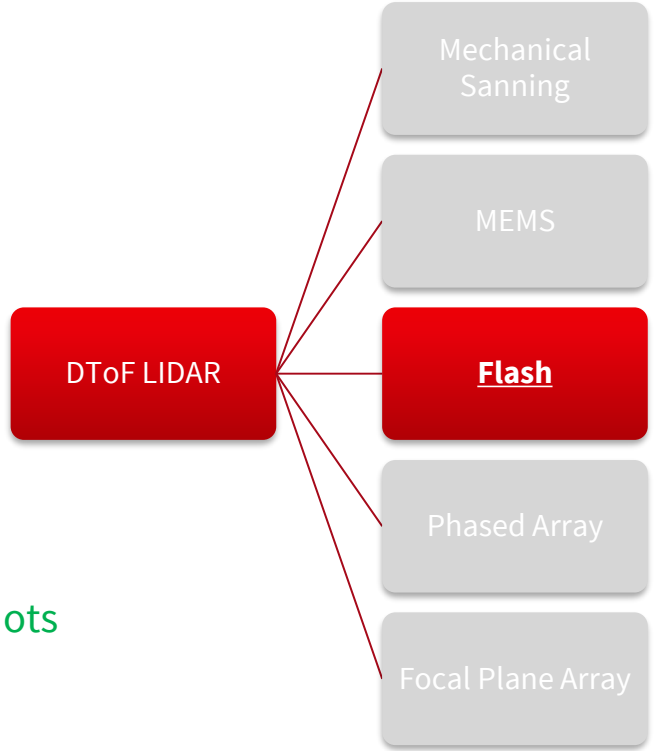
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SOLID-STATE LIDAR | FLASH



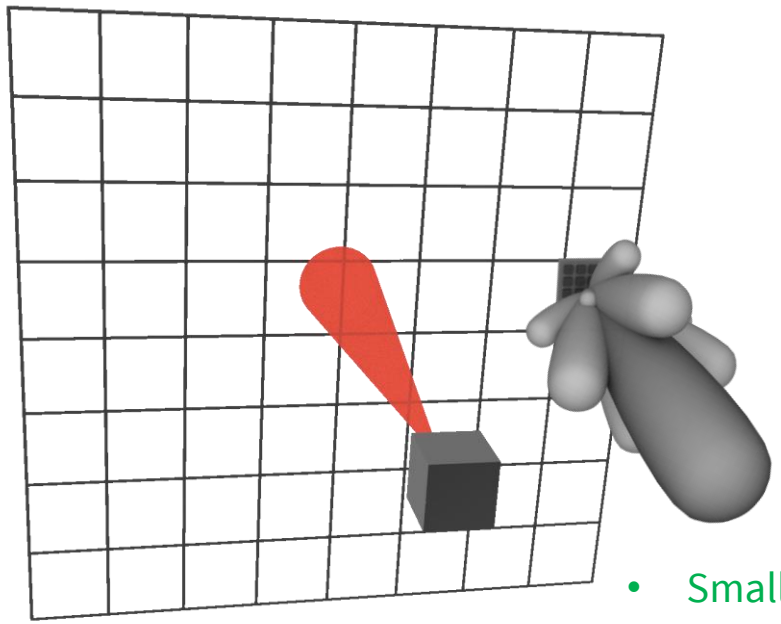
- Small size
- Captures snap shots
- No moving parts

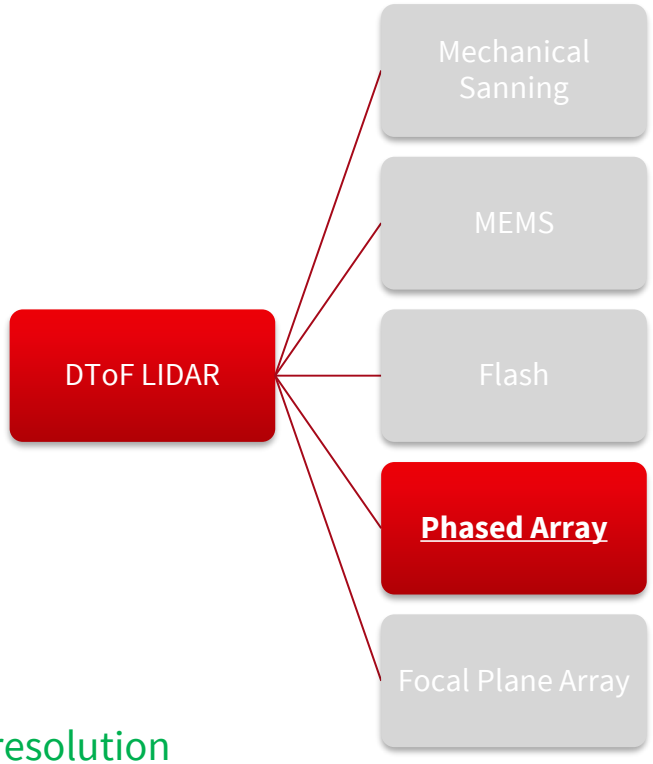
- Limited range
- Limited hor. field of view
- Angular resolution fixed



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SOLID-STATE LIDAR | PHASED ARRAY

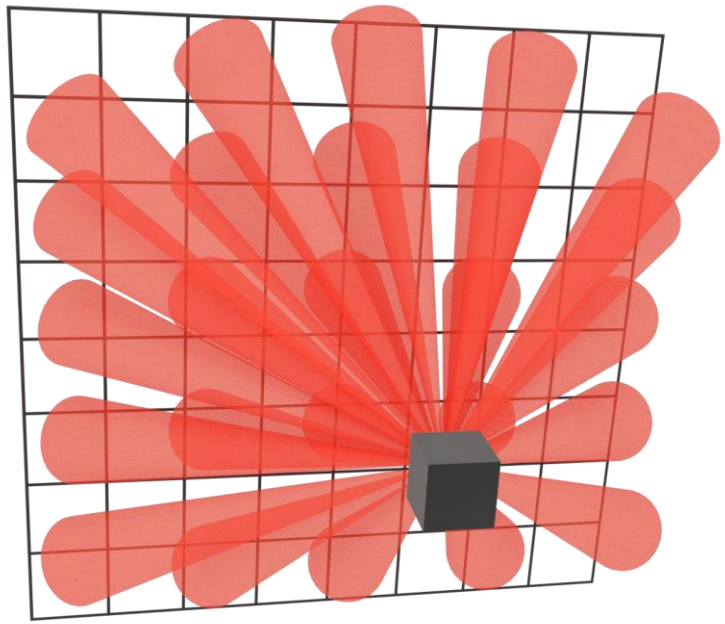


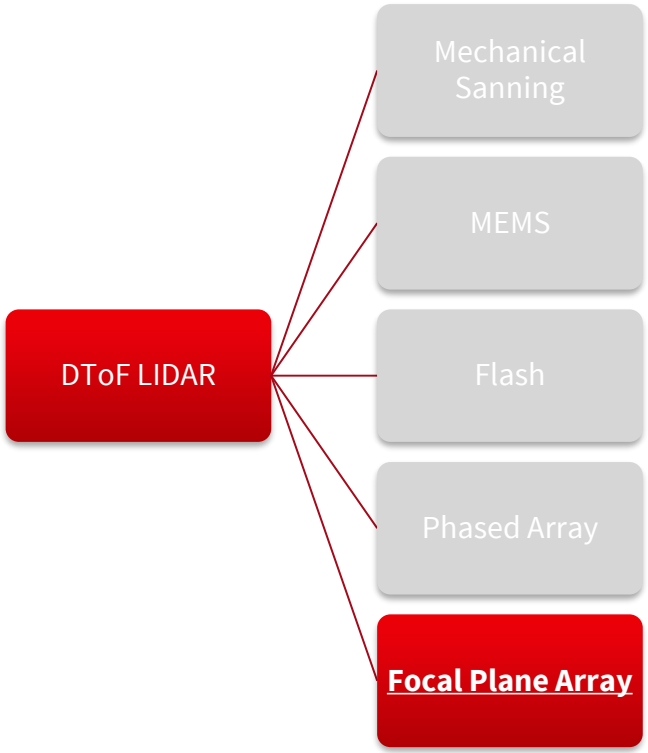


- Small size
- Two axis
- Flexible angular resolution

- Bad SNR
- Limited hor. field of view
- Low efficiency of OPA

SOLID-STATE LIDAR | FOCAL PLANE ARRAY

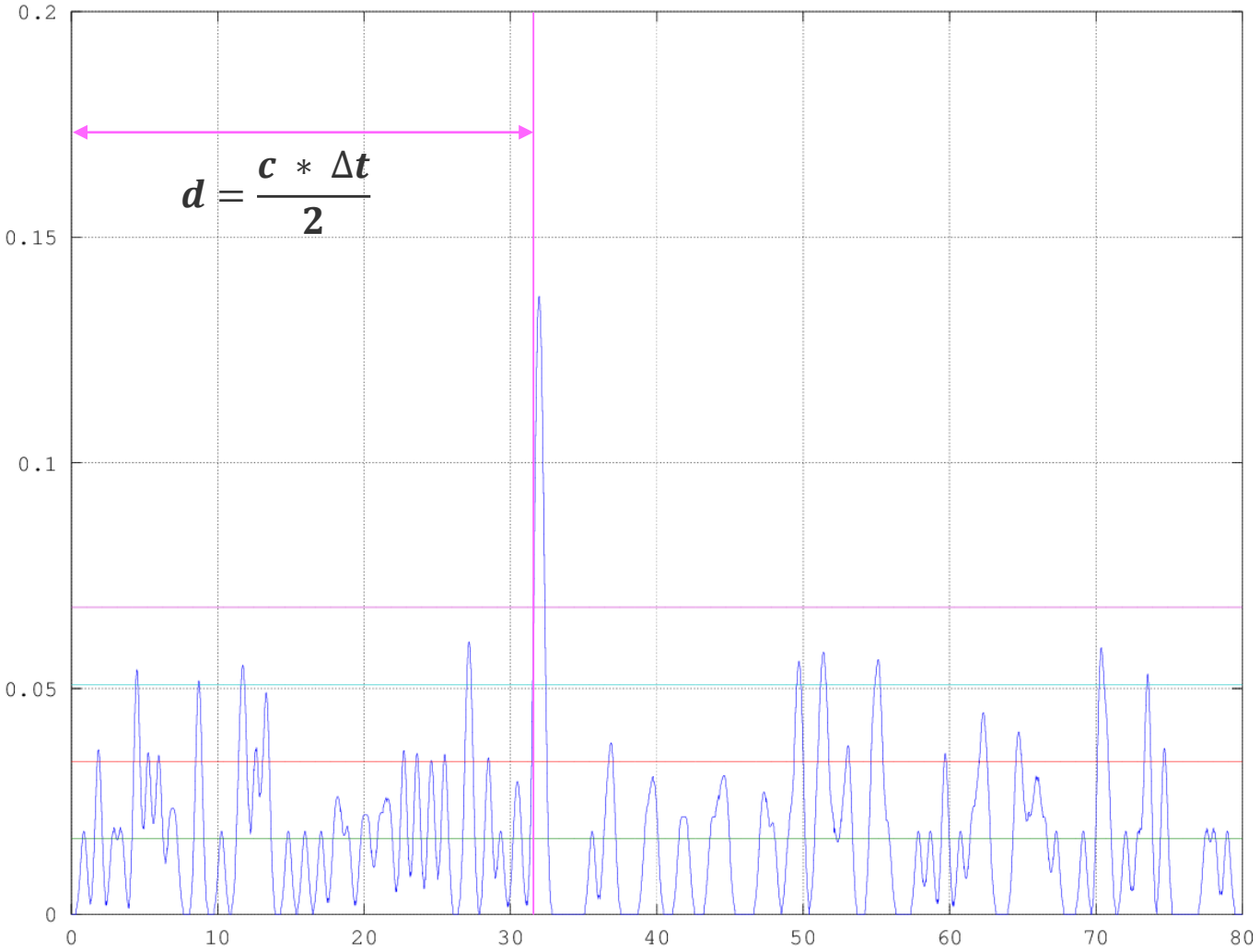




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DIRECT TOF MEASUREMENT METHODS

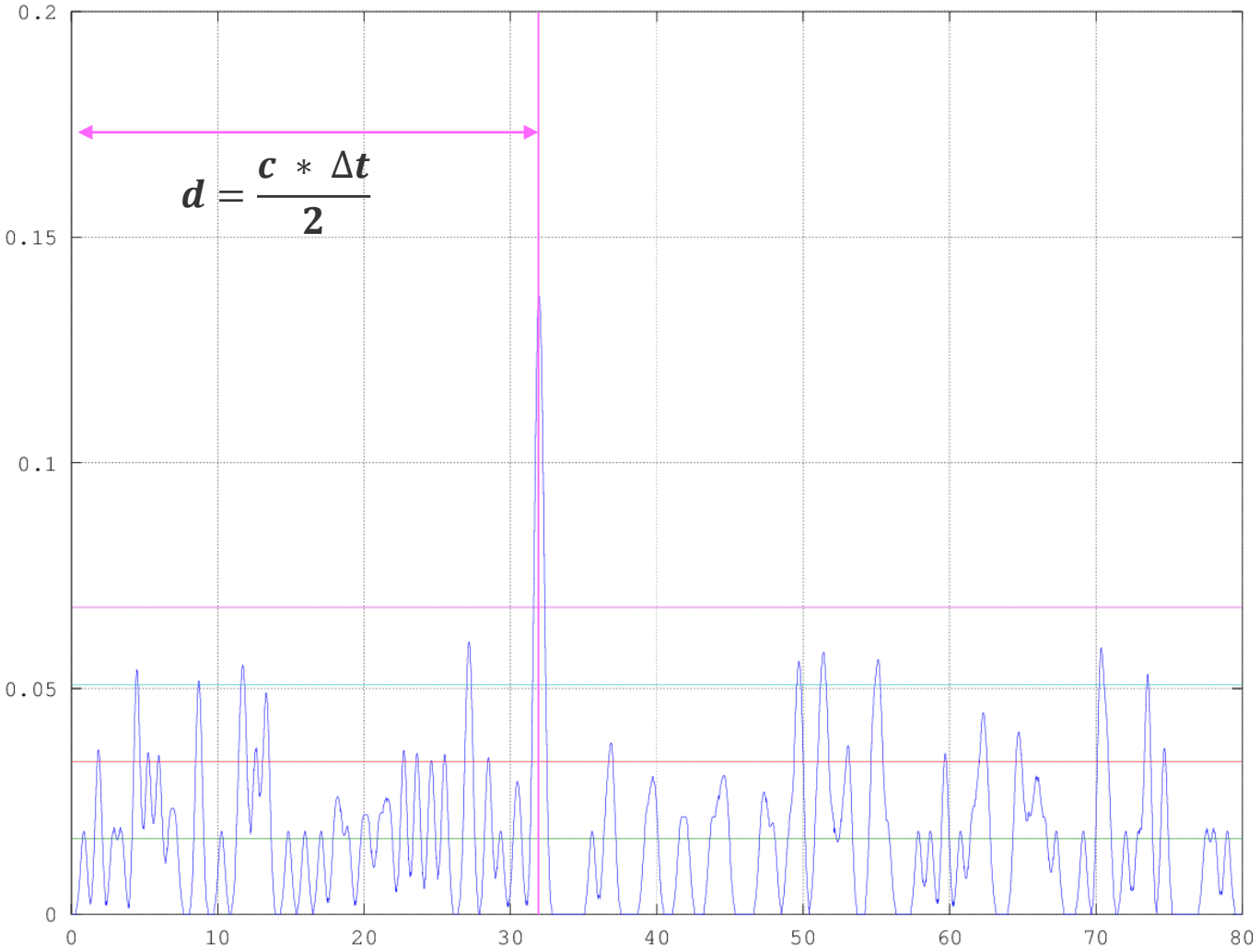
THRESHOLD DETECTION



- Cost efficient
- High distance resolution

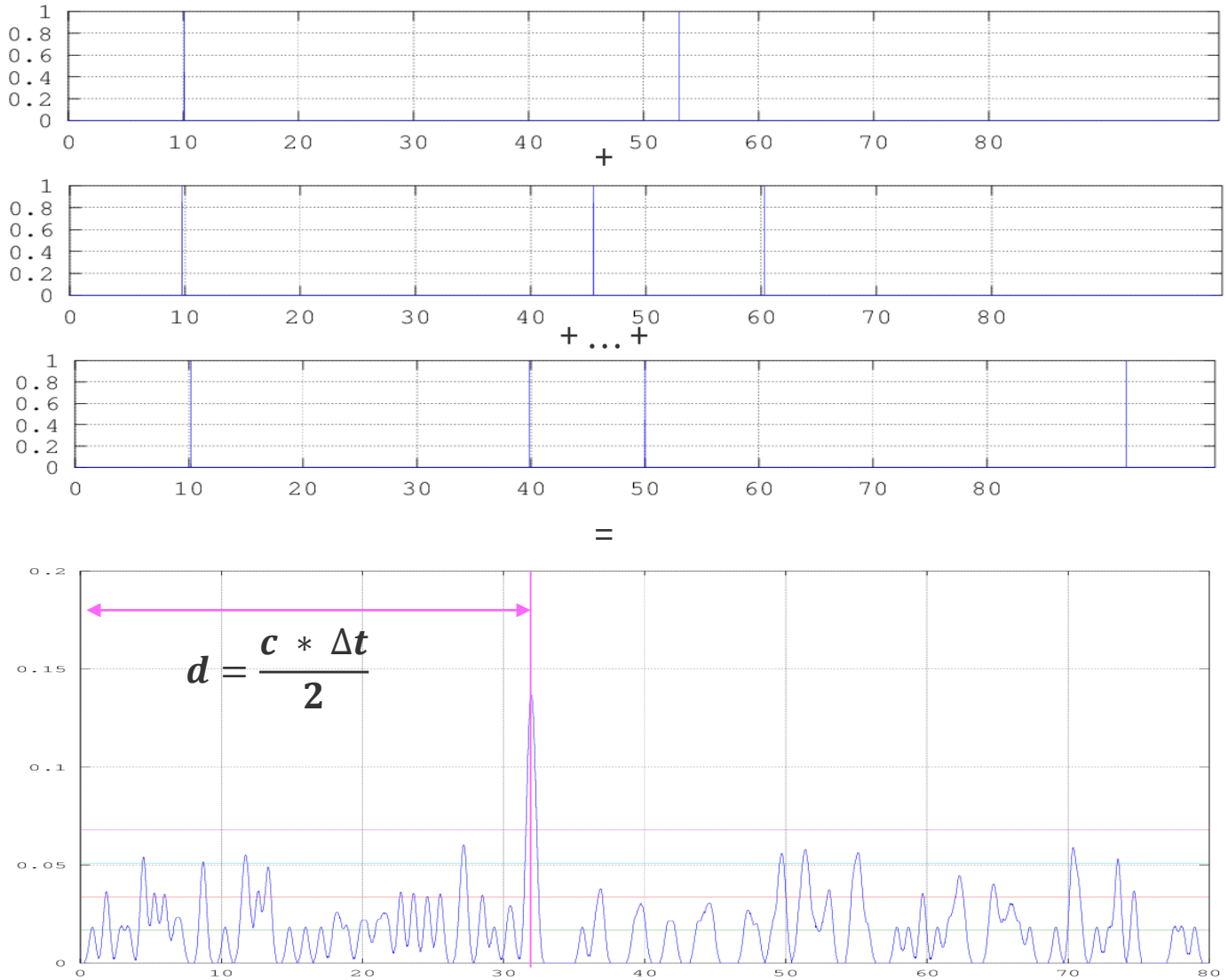
- Information on wave form lost

DIRECT SAMPLING



- Digital signal
- Costly
- Limited resolution

TIME CORRELATED SINGLE PHOTON COUNTING (TCSPC)



- Digital signal
- Cost efficient

- Limited resolution

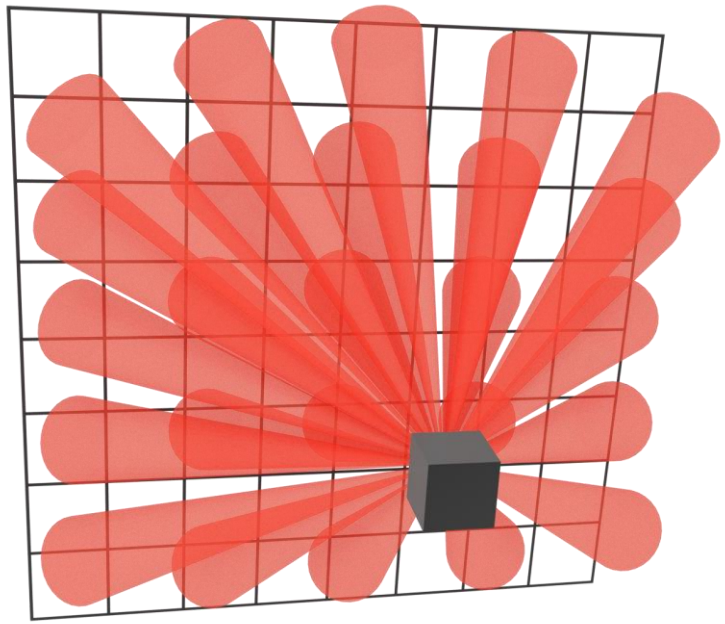


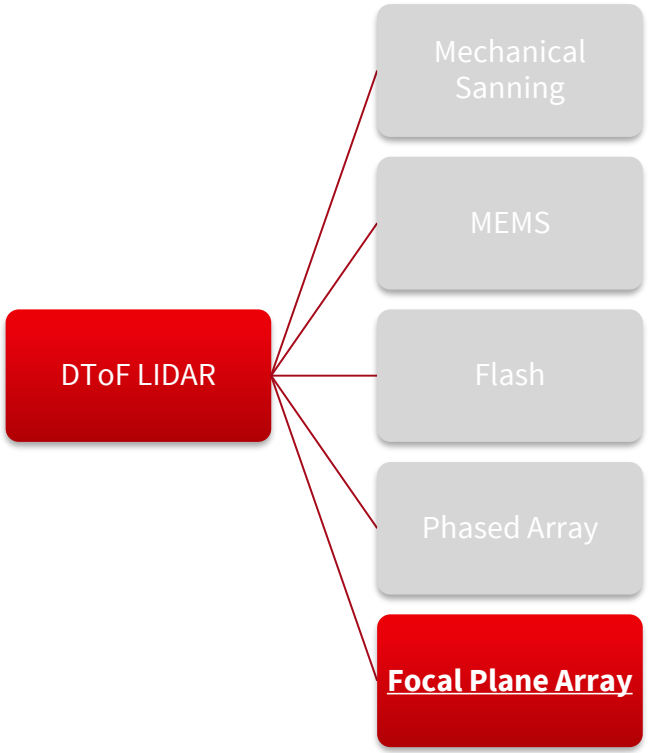
SEQUENTIAL FLASH LIDAR

ibeo automotive

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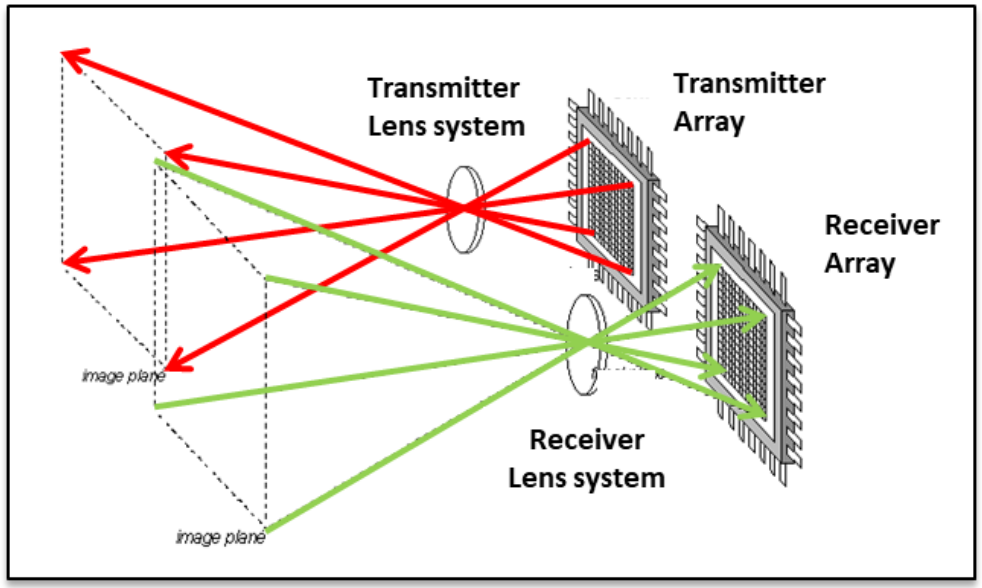
SOLID-STATE LIDAR | FOCAL PLANE ARRAY

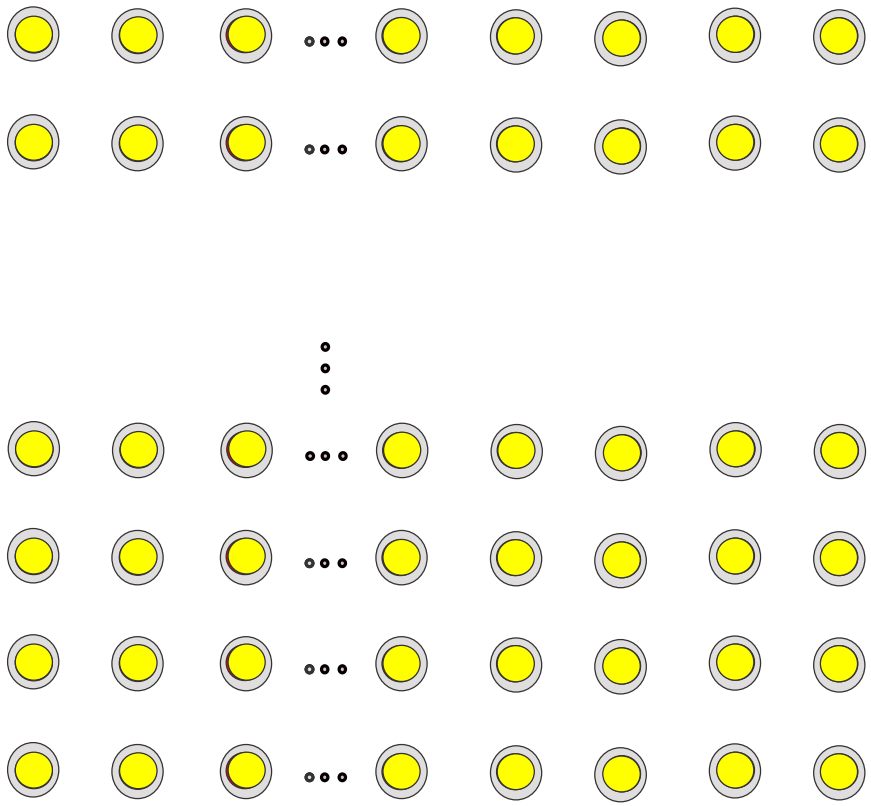




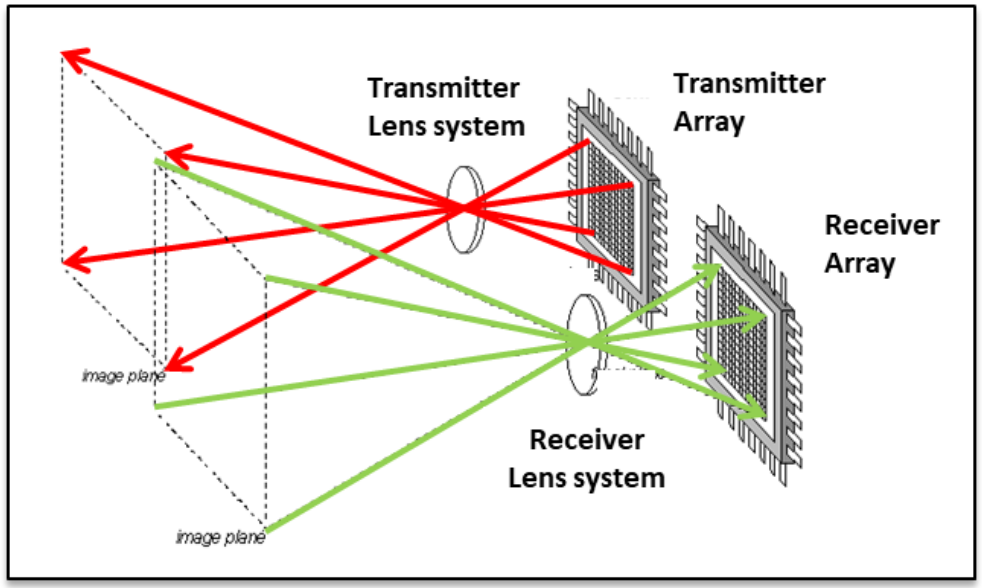
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SOLID-STATE LIDAR | SEQUENTIAL FLASH





SOLID-STATE LIDAR | SEQUENTIAL FLASH



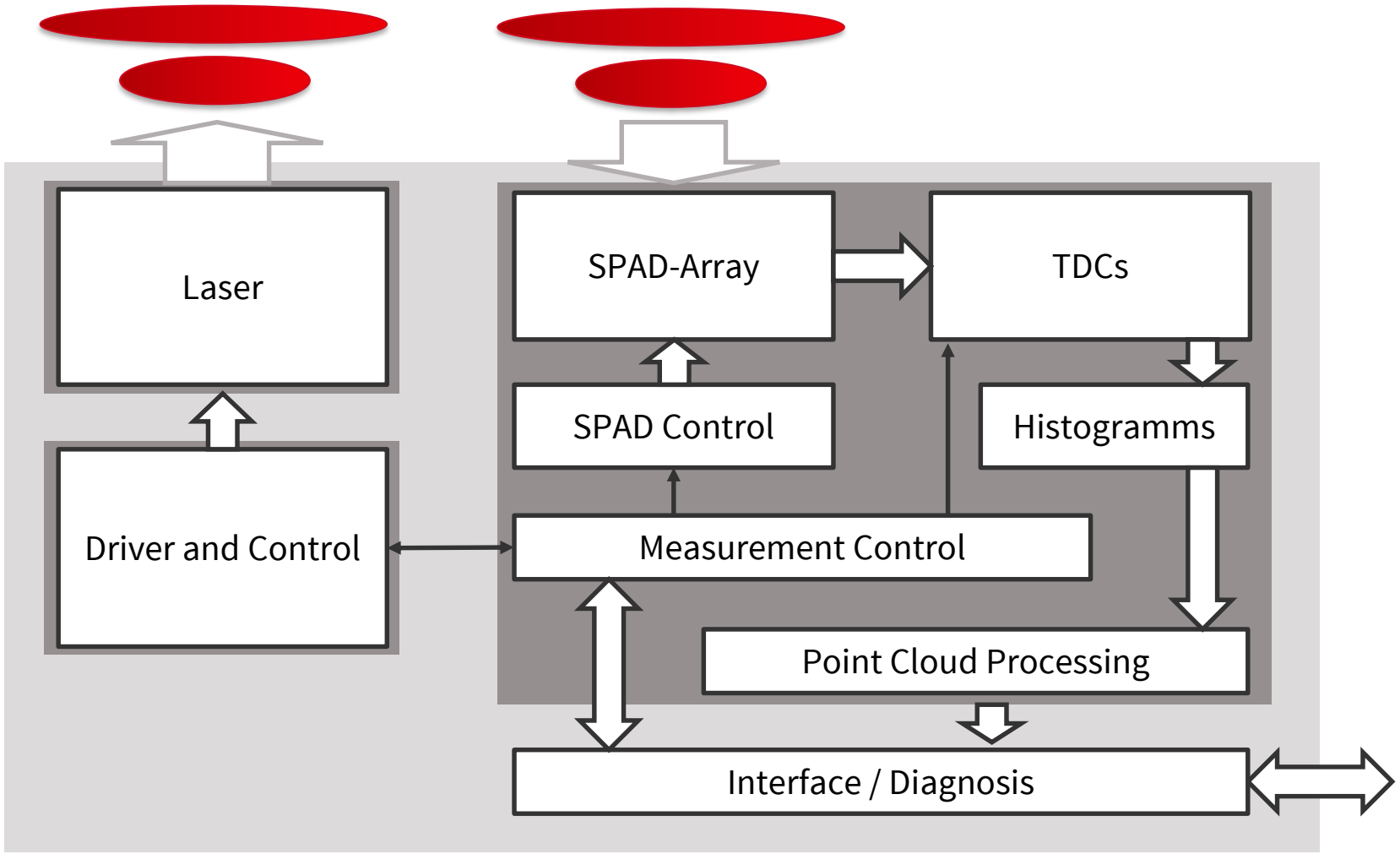


Small size
Good measurement range
No moving parts

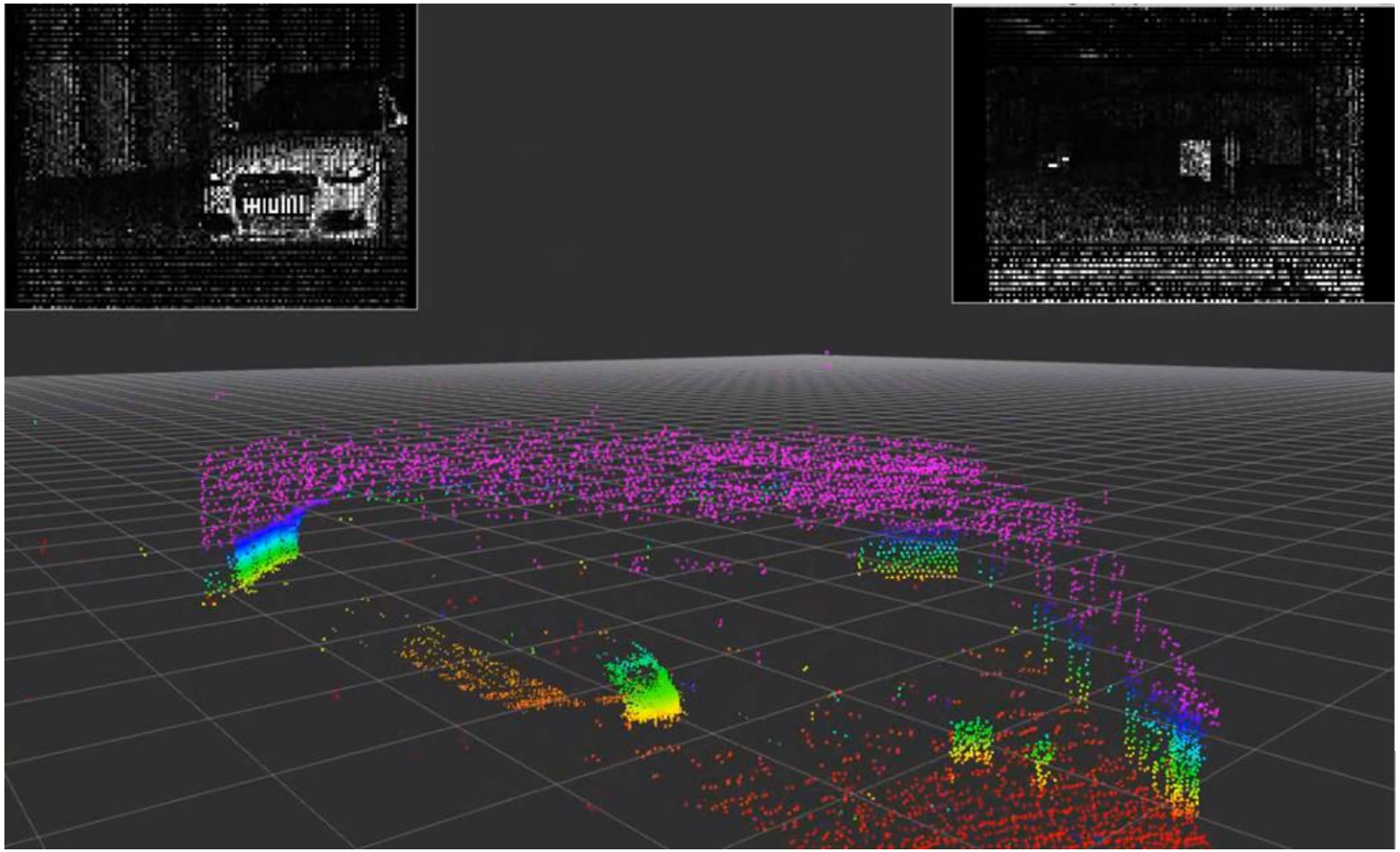
Limited hor. field of view
Angular resolution fixed
High NRE

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SYSTEM


Laser
Driver and Control
SPAD-Array
TDCs
SPAD Control
Histogramms
Measurement Control
Point Cloud Processing
Interface / Diagnosis

SAMPLE DATA





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