



Low Loss Silicon Nitride – an integrated photonics platform for solid state LiDAR

Thomas Hessler
+41 79 792 16 05

thomas.hessler@ligentec.com
October 2019

EPIC Meeting on LIDAR Technologies for Automotive

Located in Lausanne, CH
Origin from K-Lab, EPFL



EPFL



LIGENTEC

Potential of Photonic Integration



4 m³

1998

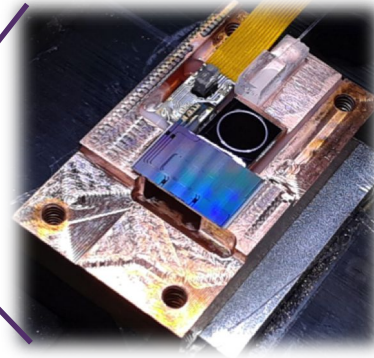
MenloSystems



1 m³

2008

CORES
Chip-scale Optical Resonator Enabled Synthesizer



1 cm³

2019

SWaP

- ✓ Size
- ✓ Weight
- ✓ Power
- ✓ Robustness
- ✓ Cost

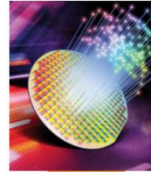
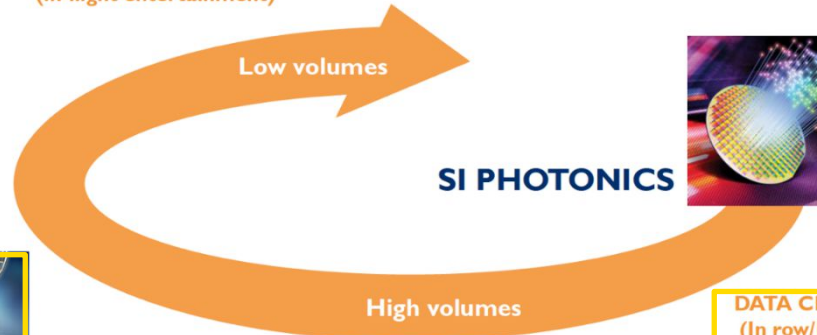
Silicon Photonics Applications



AERONAUTICS
(in-flight entertainment)



SPACE (QKD, comm)

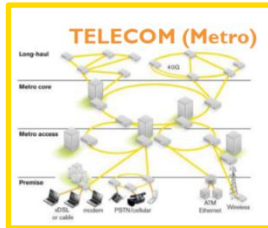


SI PHOTONICS

AUTOMOTIVE
(low latency for autonomous cars)



MEDICAL



TELECOM (Metro)

HIGH-PERFORMANCE COMPUTING



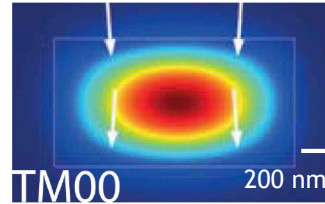
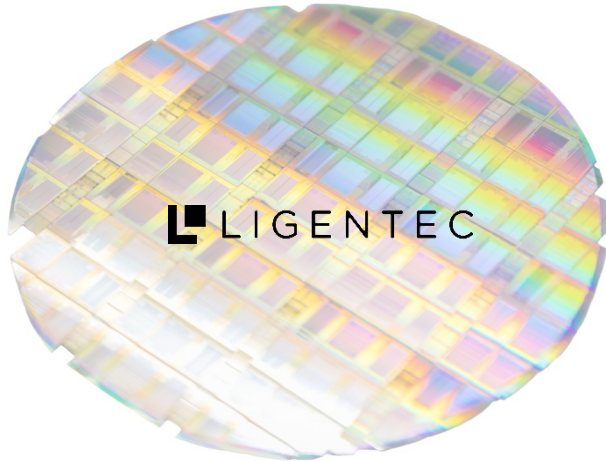
DATA CENTRES
(In row/Inter/Intra)

Silicon Photonics Challenges

- × High propagation losses
- × Low optical power handling
- × Narrow transparency window
- × Expensive I/O coupling

Silicon Photonics 2.0

Our game Changer: Thick Film Silicon Nitride



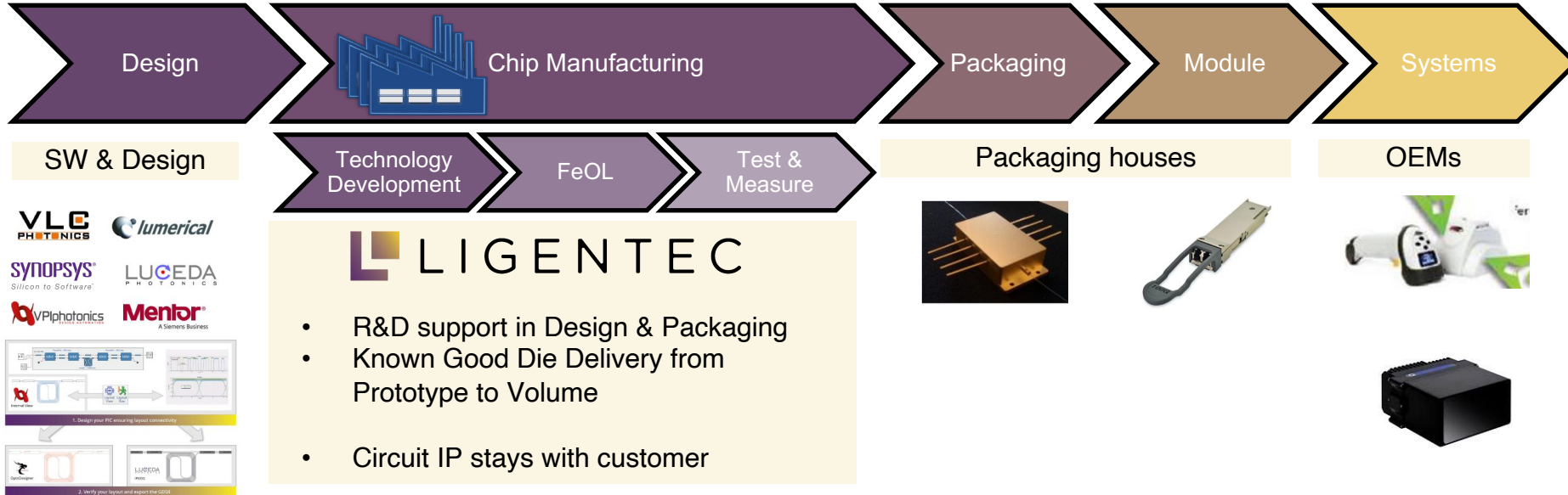
90% light confined in SiN waveguide:

- ✓ Low loss (< 0.1 dB/cm)
- ✓ Small chip size
- ✓ High Yield
- ✓ VIS to IR
- ✓ High optical power handling (Watts)

All Nitride Core Technology: combining the benefits of

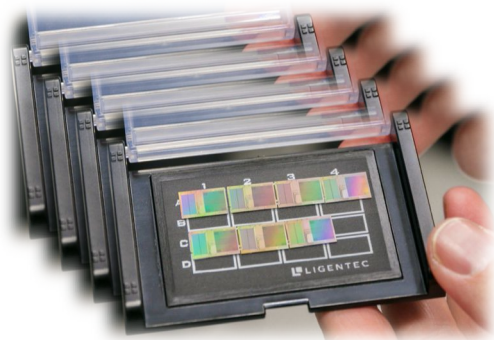
- Silicon Nitride (VIS-IR, low loss, high power) with
- Silicon Photonics (small chip size)

Business Model & Offering



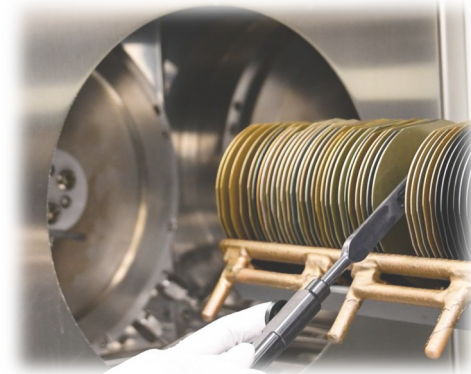
Multi Project Wafer Runs

- AN800 (IR), AN150 (VIS)
 - Preset process modules
 - 7 chips (5mm x 10mm)
 - Fast (10 weeks)
 - 4x per year, fixed dates
- www.ligentec.com/Ligentec-foundry/



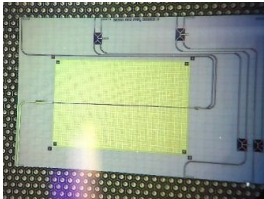
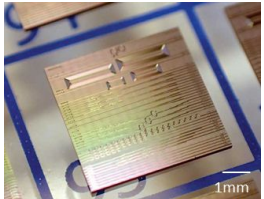
Custom Runs

- Can start any time
- Fast track options
- Full choice of process modules
- Custom thickness
- Custom quantities



Modular Process Portfolio

Base Process

PDK with tested Building Blocks available	AN150		visible wavelength
	AN800		1280-1650nm wavelength
	ANcustom		Other wavelength, high level of customization

Selected Advanced Modules

WAVEGUIDE

WAVEGUIDE

X2. Multi level photonic circuits

HEATER

SiN

M1. High efficiency heaters for thermo-optic tuning



LoCA. Local cladding open for sensing and bonding

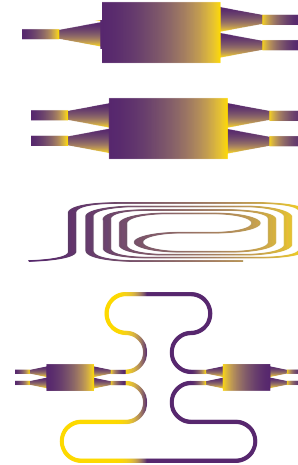
Components to realize e.g. a FMCW coherent LiDAR

LiDAR Requirements

- Range
- Resolution
- Cost
- Size
- Power

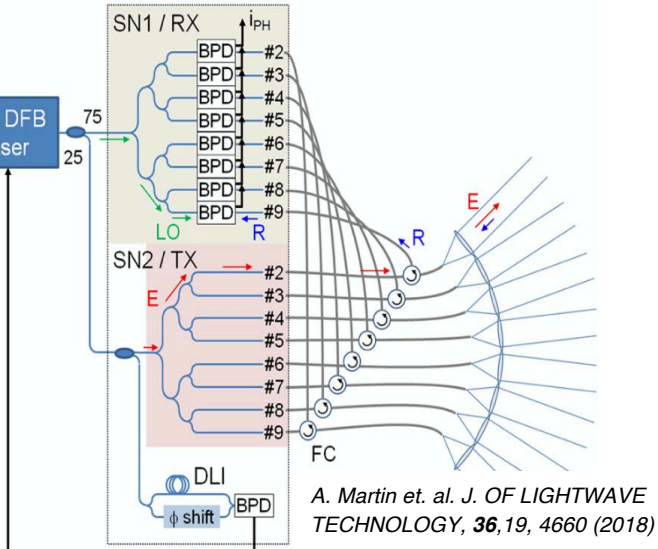
PIC Building Blocks

- MMIs
- Delay lines
- MZIs
- Phase Modulators
- Optical I/Os



BB requirements

- Low loss
- Low phase errors
- High laser power





TE-TE

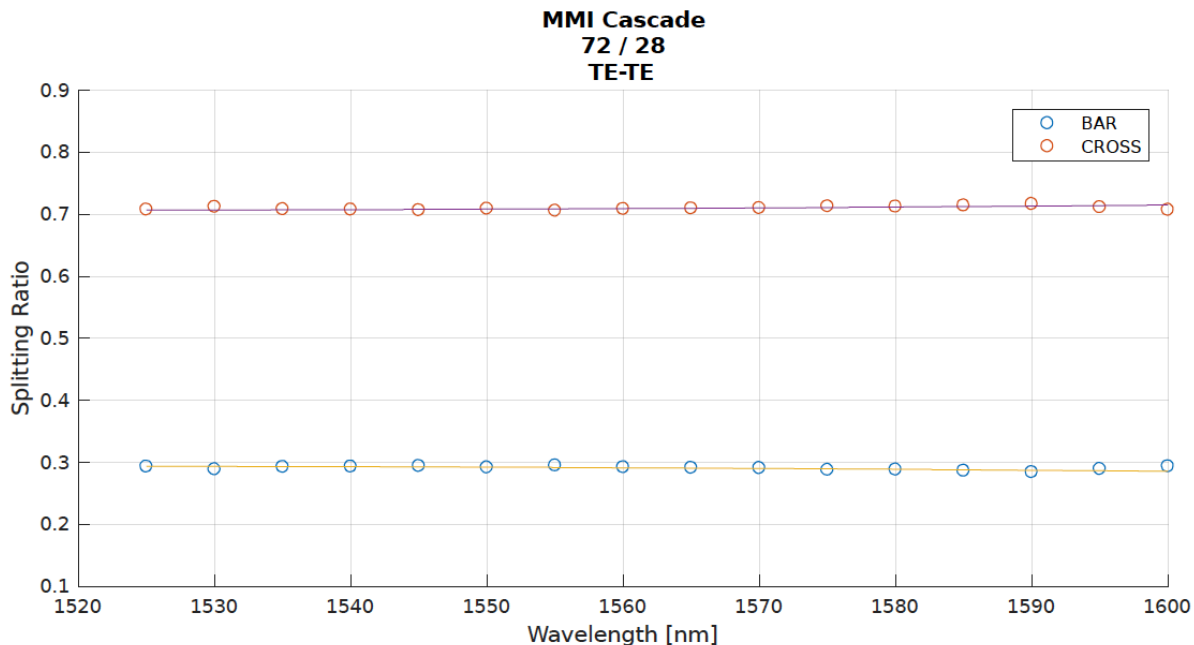
SR@1550nm:

Cross → 0.708
Bar → 0.292

SR@1550nm:

Cross → 0.693
Bar → 0.307

TM-TM

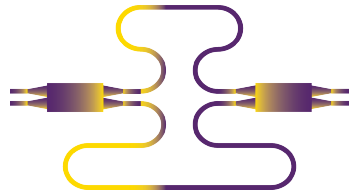
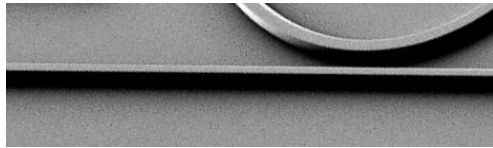


First time right possible

Delay Lines & Delay Line Interferometers (DLIs)



- Short bend radii
 - Low loss 5 dB/m
- => Long delay lines



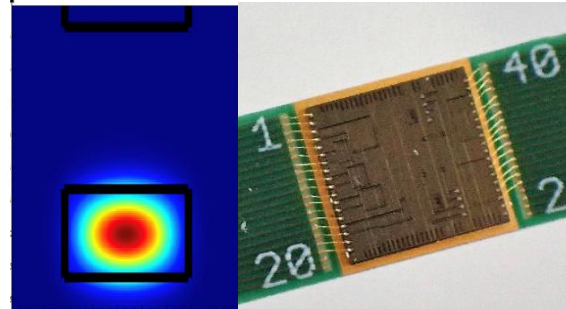
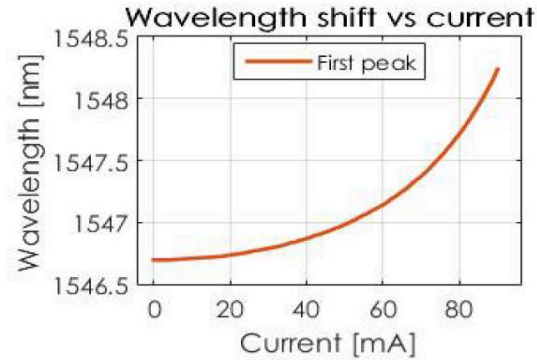
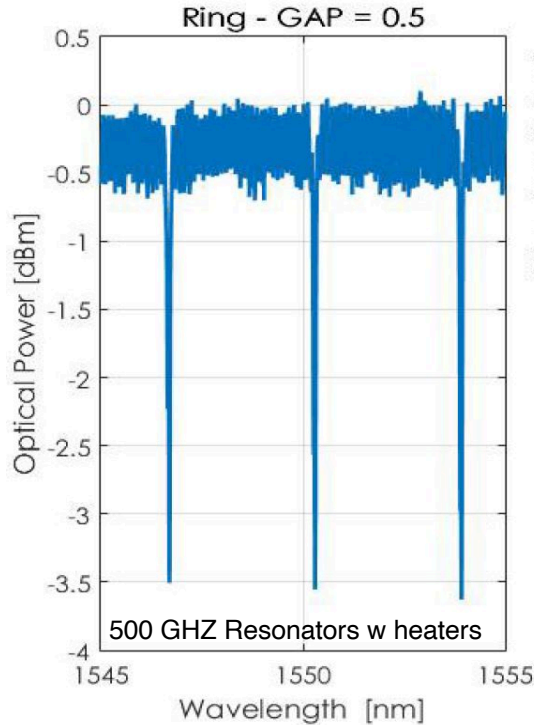
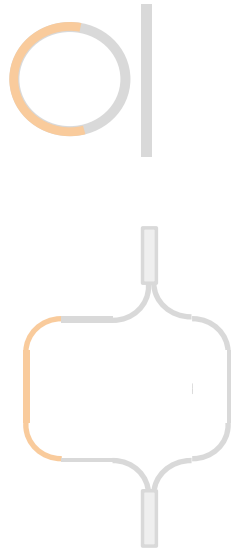
- Small waveguide roughness
 - High mode confinement
- => Low loss & low phase noise



Delay lines up to 1 m on 5x5 mm²

Long and low phase noise delay lines enable high resolution FMCW LiDAR

Phase Shifting - Thermal circuit tunability with no additional losses.

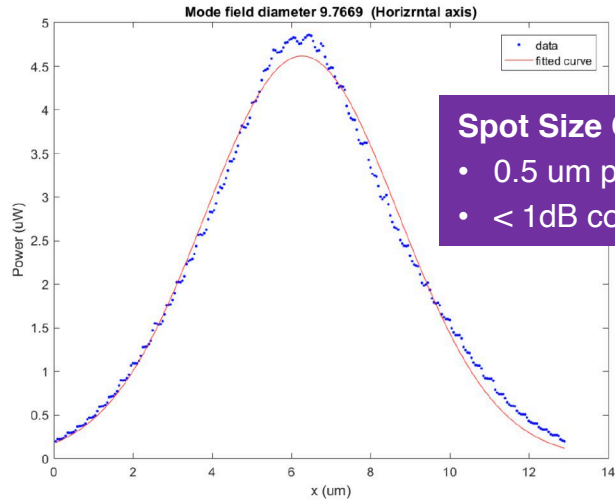


- Speed 25kHz
- 100mW for pi shift
- Up to 4nm tuning, several FSR / pi-shifts

Narrow gap & high mode confinement results in efficient tuning

Optical I/Os

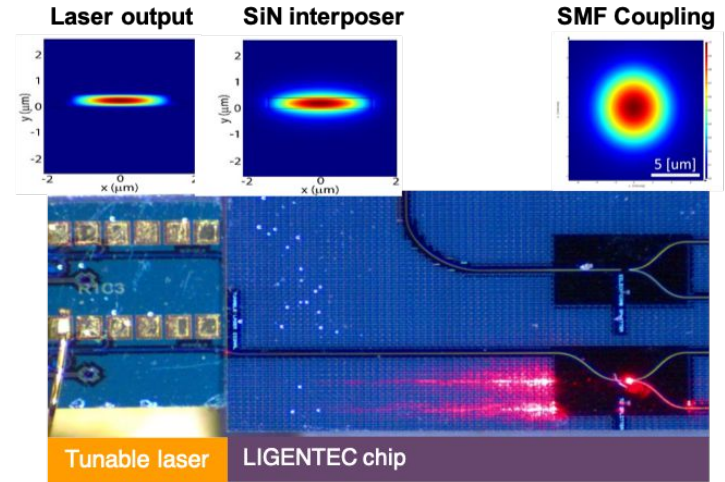
- Vertical grating couplers
- Edge coupling with spot size converter



Spot Size Converter

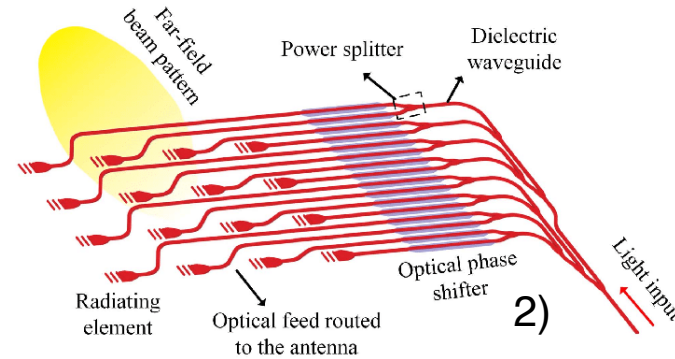
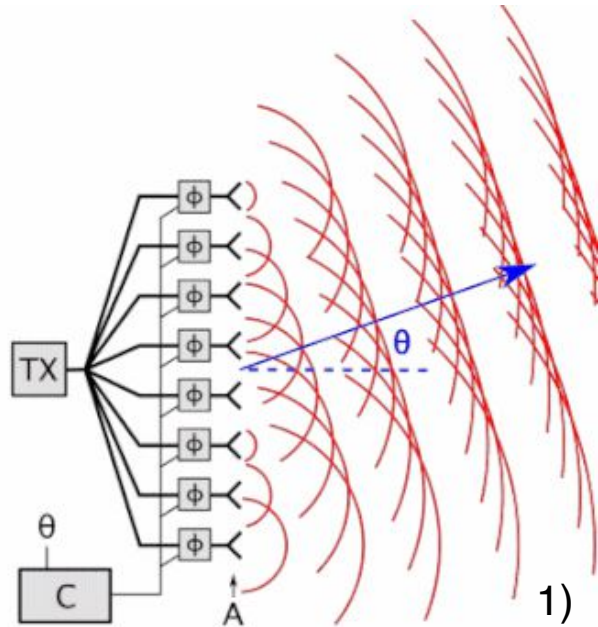
- 0.5 μm position tolerance
- < 1dB coupling loss

- Heterogeneous integration to other material platforms with mode conversion or bonding



Relaxed tolerances reduces packaging cost

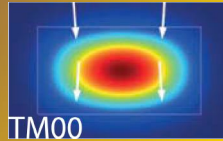
Optical Phase Array (OPA)



- ✓ Low loss & high power light propagation
 - ✓ Low loss phase shifter
 - ✓ Vertical grating couplers
- => Enabling for OPAs

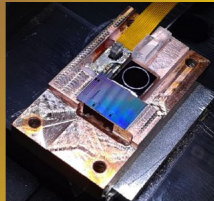
The Basics

- ✓ High Mode Confinement
- ✓ Low Loss
- ✓ Small Footprint
- ✓ High Power



Actives

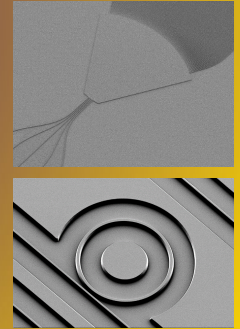
- ✓ Electrical Tuning
- ✓ Modulators
- ✓ Lasers
- ✓ Detectors



WE ARE HIRING

Full Creativity

- ✓ Couplers
- ✓ Mux / DeMux
- ✓ MZIs / DLIs
- ✓ Resonators
- many more



World Connections

- ✓ Edge Coupling / U Grooves
- ✓ Spot Size Converter
- ✓ Grating Couplers
- ✓ Arbitrary Die Shape
- ✓ Bond pads

How can we help you? How can you help us?

We for you:

Partner for low loss PICs

- Low entry barrier MPW runs
- Building Block Development
- Custom PICs
- Prototype to Volume

Established & sound partner network for

- Design
- Free Space Optics

You for us:

Challenge us with specific LiDAR requirements

Complement the PIC supply chain:

- Wafer Level Testing
- Packaging

This presentation was presented at EPIC Meeting on LIDAR Technologies for Automotive 2019

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