DVN LiDAR Conference 2021

TRIOPTICS
See the Difference

Dirk Seebaum, November 16, 2021

TRIOPTICS

Automotive LiDAR – solutions for optical alignment and testing in mass production

Experience – ProCam® product innovations for camera assembly

ProCam® Smart Proto
System for a small series production of surveilance cameras

ProCam® Inline
First assembly & testing device for high volume production of camera modules

ProCam® CamTest
ADAS camera production line

2012 | 2014 | 2016 | 2018 | 2020 | 2022

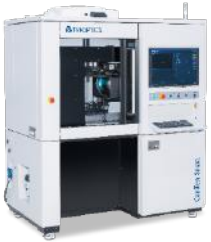
ProCam® Align
First system with AA, glue dispensing & UV curing for a medical application

ProCam® Align Smart
Semi-automated series production of camera modules

ProCam® TT
The fastest & most precise assembly station for camera mass production

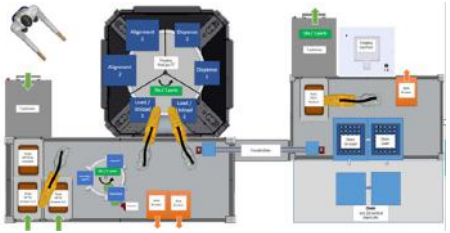
Experience – ProCam® product innovations for LiDAR assembly

ProCam® Align Smart
Optical alignment of emitter/receiver moduls
λ = 905nm

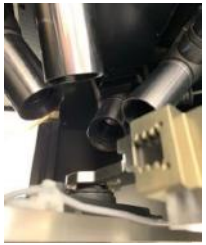


Inhouse prototype manufacturing of Solid State Emitter & receiver modules

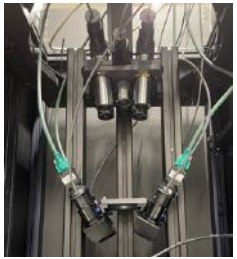
Fully automated ADAS LiDAR production line (alignment & testing)
λ = 880nm



2018 | 2019 | 2020 | 2021 | 2022

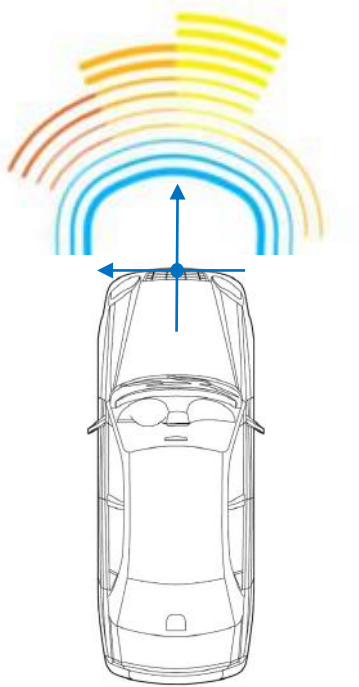


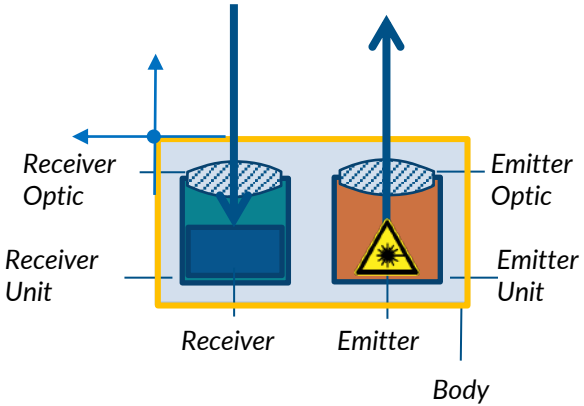
ProCam® TT
5 axis alignment of Flash LiDAR receiver
λ = 905nm



Process equipment
λ = 1550nm

LiDAR sensor module optical alignment and testing processes





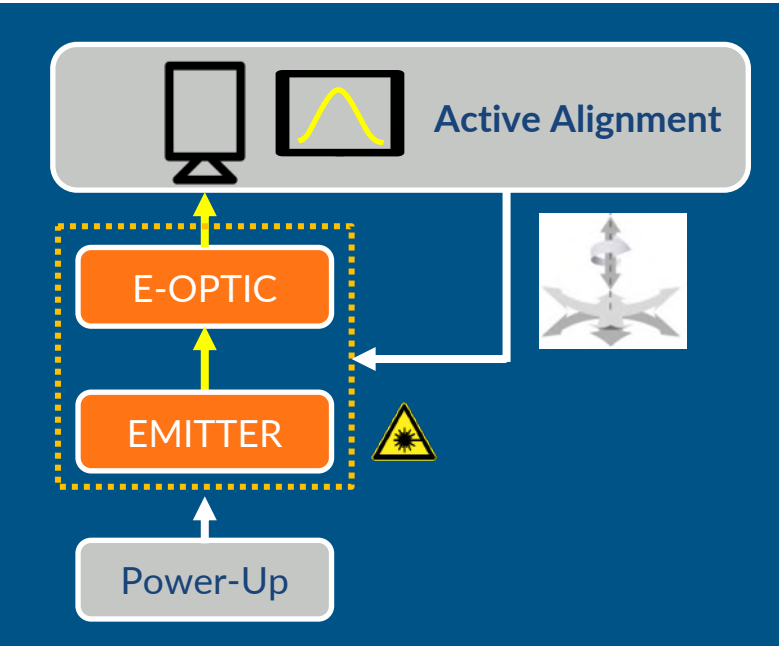
Optical alignment tasks…

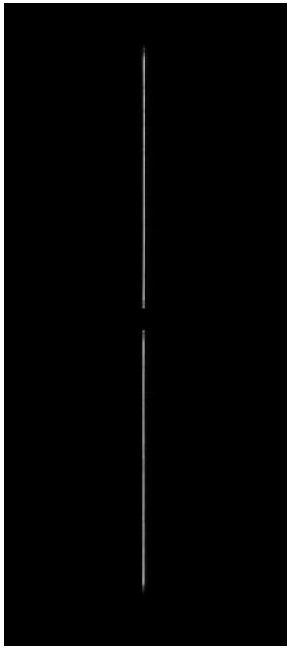
- Emitter Unit (Emitter + Optic)
- Receiver Unit (Receiver + Optic)
- Emitter Unit to Body
- Receiver Unit to Body

… and procedures

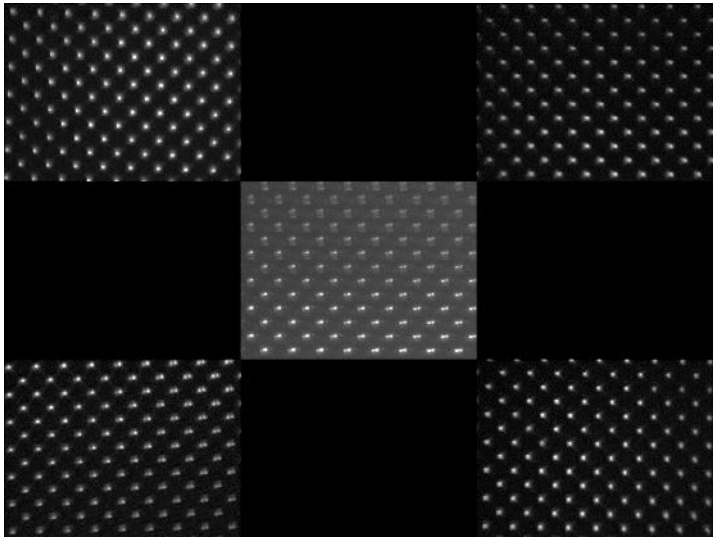
- active alignment
- passive alignment

Active alignment process



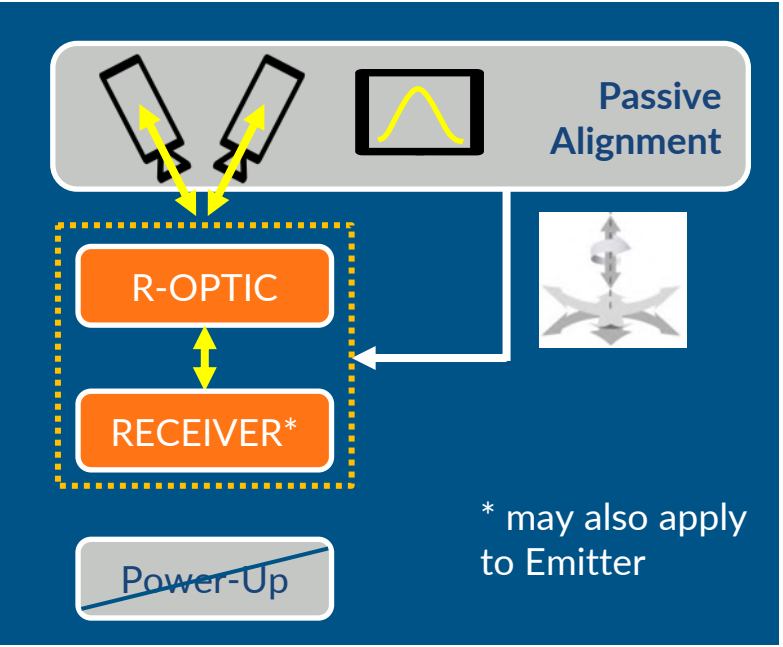


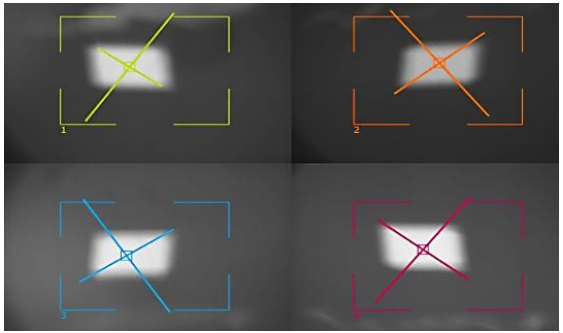
Example 1



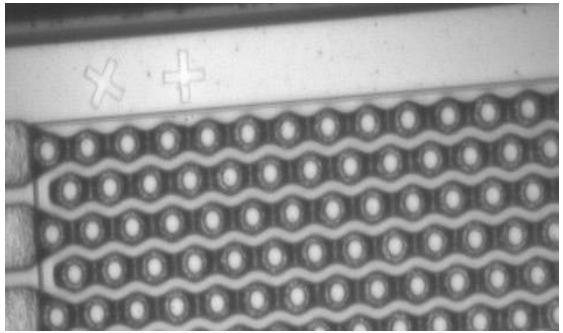
Example 2

Passive alignment process



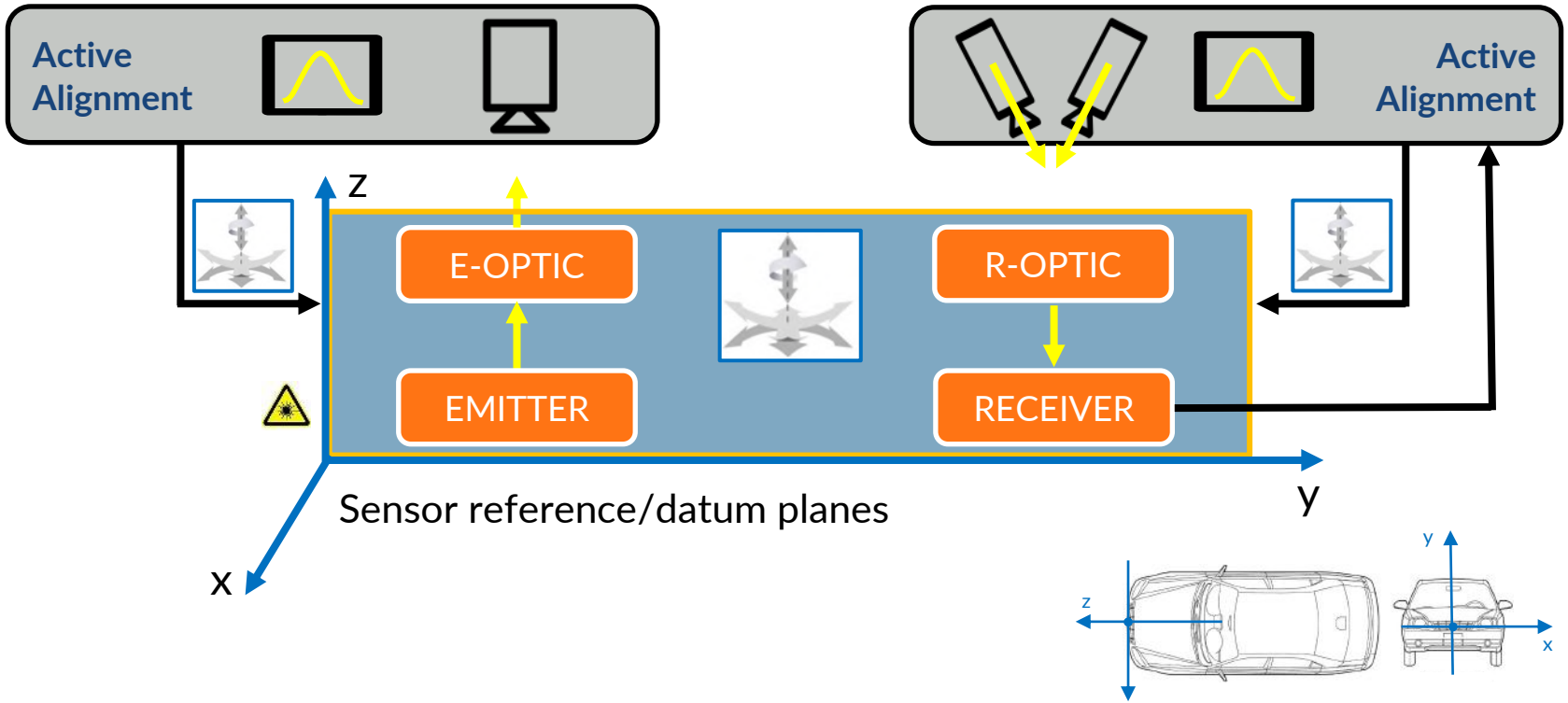


Example 1
(with Markers)

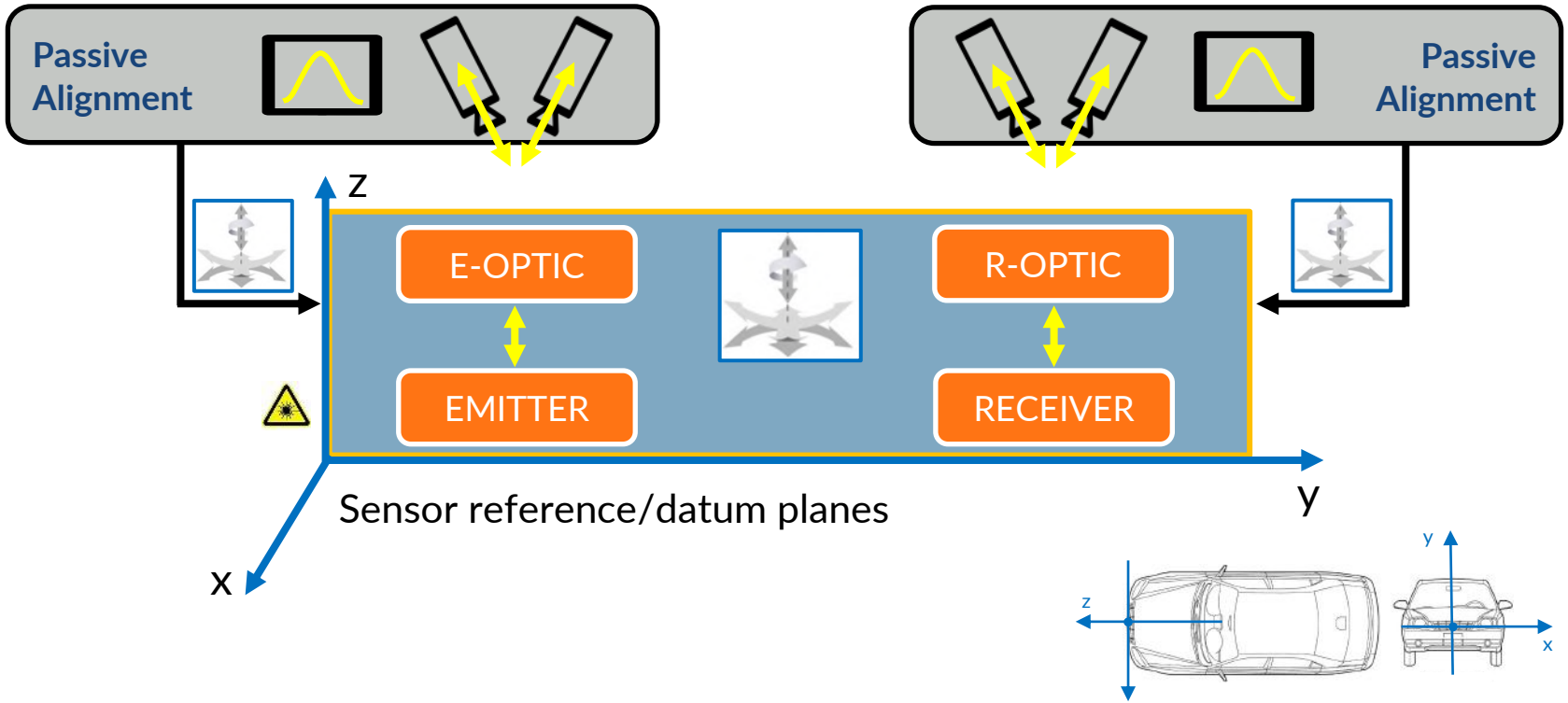


Example 2
(with Active area)

Process selection – active / active for LiDAR alignment



Process selection – passive / passive for LiDAR alignment



LiDAR alignment capabilities

Specified Repeatabilities:

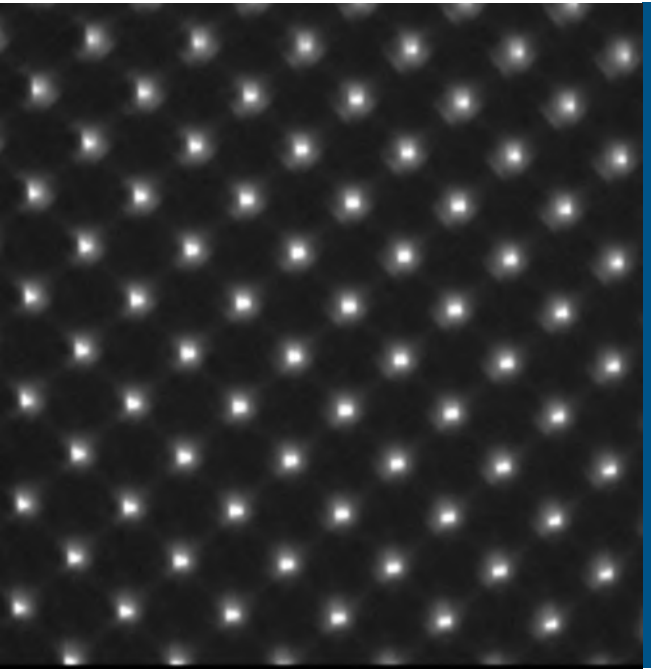
- Best Focus Z +/- 5µm (5σ)
- Decentering X/Y +/- 1µm (5σ)
- Tilt Alignment X/Y +/- 200µrad (5σ)

Results from current project:

Active Emitter Alignment	Repeatability (5σ)	Unit
Best Focus	± 3,360	µm
Tilt Alignment X	± 32,636	µrad
Tilt Alignment Y	± 137,772	µrad
Decentering X	± 0,174	µm
Decentering Y	± 0,407	µm

Emitter: 940 nm, objective lens: 60° FOV, EFL: 15mm

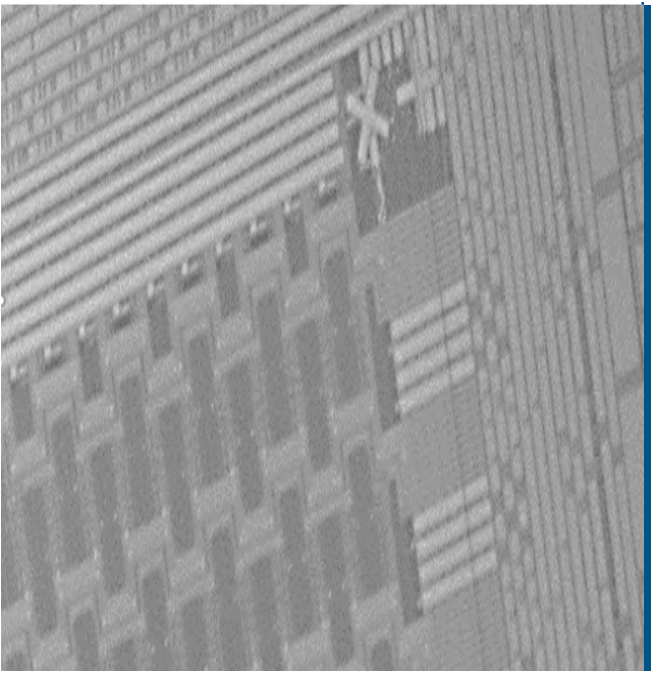
Active alignment LiDAR projects



Active Alignment Projects

- Time of Flight Camera for automotive Kick Sensor
  - Module type - Emitter module
  - Working Wavelength - 905 nm
  - Cycle Time - 30 sec
- Laser scanner with rotating mirror module for ADAS
  - Module type - Emitter module
  - FOV - 70 degree; Working Wavelength - 905 nm
  - Cycle Time – 45 sec
- Flash LiDAR for ADAS Module
  - Module type - Emitter and Receiver module
  - FOV – 30, 45, 60 degree; Working Wavelength - 940 nm

Passive alignment LiDAR projects



Passive Alignment Projects

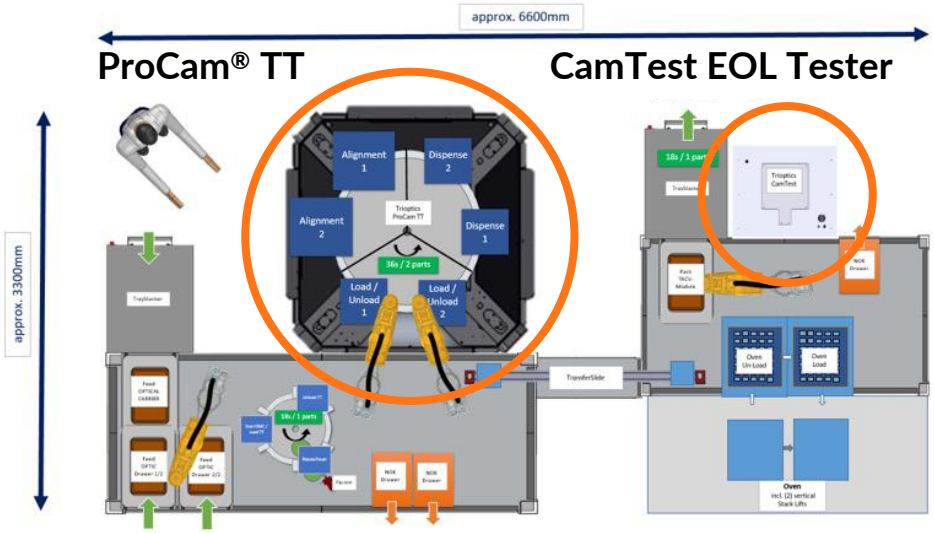
- High Resolution Flash LiDAR for ADAS
  - Module type - Receiver module (SPAD Array)
  - FOV - 135 degree; Working Wavelength - 905 nm
  - Cycle Time - 70 sec
- High Resolution Flash LiDAR for ADAS
  - Module type – Emitter and Receiver module
  - FOV – 11, 60, 120 degree; Working Wavelength – 880 nm
  - Cycle Time - 18 sec
- High Resolution Flash LiDAR for ADAS
  - Module type –Receiver module
  - FOV – 28, 130 degree; Working Wavelength - 1550 nm

Automotive camera assembly line (optical alignment & testing)

Production line for ADAS cameras

- Prime Contractor:
  PIA Automation
- Sub Contractor:
  TRIOPTICS GmbH, Germany

Automotive LiDAR assembly line (optical alignment & testing)



Production line for automotive LiDAR

- Prime Contractor:
  TRIOPTICS GmbH, Germany
- Sub Contractor:
  PIA Automation, Germany

LiDAR assembly and testing production line

Production line for automotive LiDAR
Cycle Time <20s

ProCam® TT
Assembly and optical alignment of emitter & receiver

- Glue dispensing
- Optical Alignment
- UV curing

CamTest EOL Tester
LiDAR module optical test after oven curing

- Remeasure focus position, decentering, tilt

Automotive LiDAR testing equipment

Test equipment for automotive LiDAR

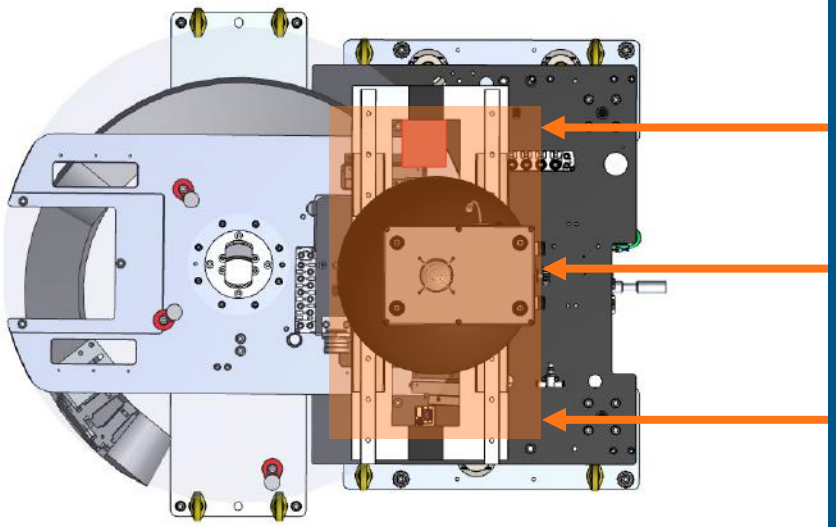
- Pre-assembly

testing of function and properties of electrical and optical sensor components

- Post-assembly

performance tests of the completed LiDAR sensor

Automotive LiDAR testing equipment – Pre-assembly



Pre-assembly test equipment for automotive LiDAR

Test 1– Emitter power, pulse, wavelength

Test 2 – Receiver OECF, homogeneity, pixel test

Test 3 – Single emitter test

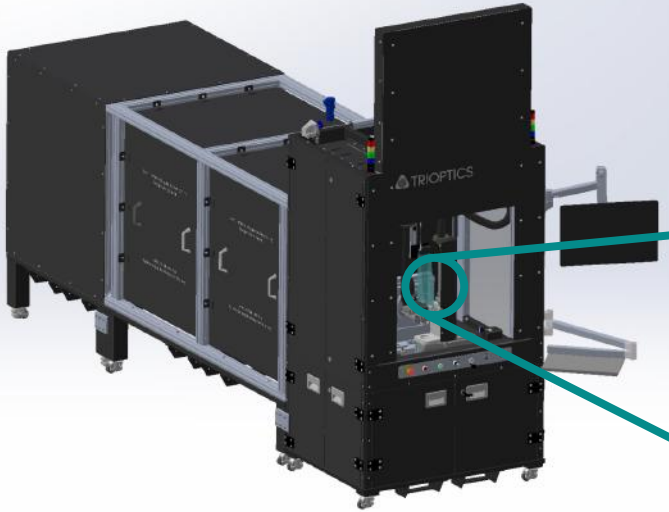
Automotive LiDAR testing equipment – Post-assembly

Post-assembly test equipment for automotive LiDAR

- Scatter plate test
- Reflectivity chart test
- Focus test

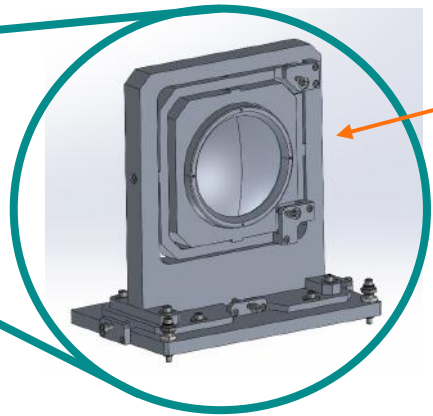
– Automated inspection systems
– Interface for customer-specific measurement procedure
– Manual or automatic (robot) loading

LiDAR Post-assembly- scatter plate test



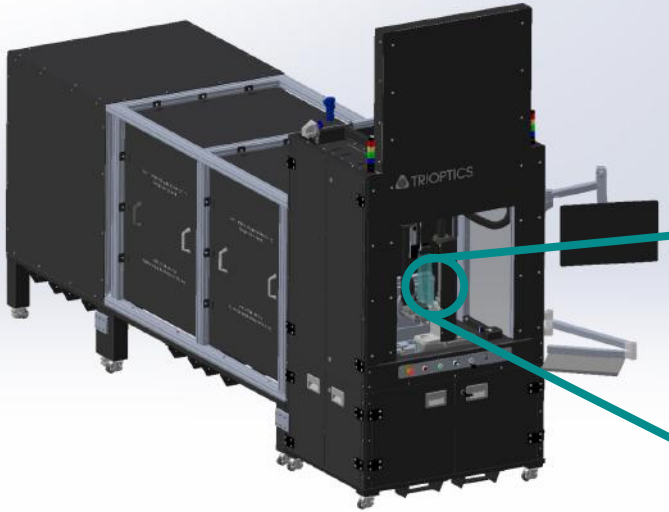
NIR doublet lens, f = 3m
to reduce length of measurement distance to 50%

- <1% transmission loss
- Abberations optimized for position variance of DUT



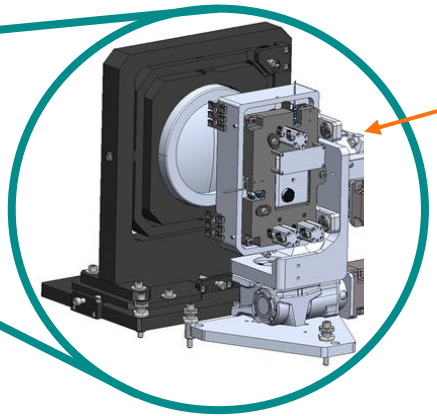
Focusing Lens

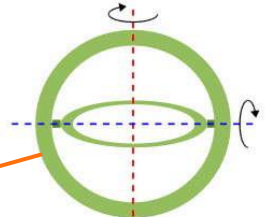
LiDAR Post-Assembly- Scatter plate test



Gimbal system to move LiDAR sensor over the entire FOV at high positioning speed and accuracy:

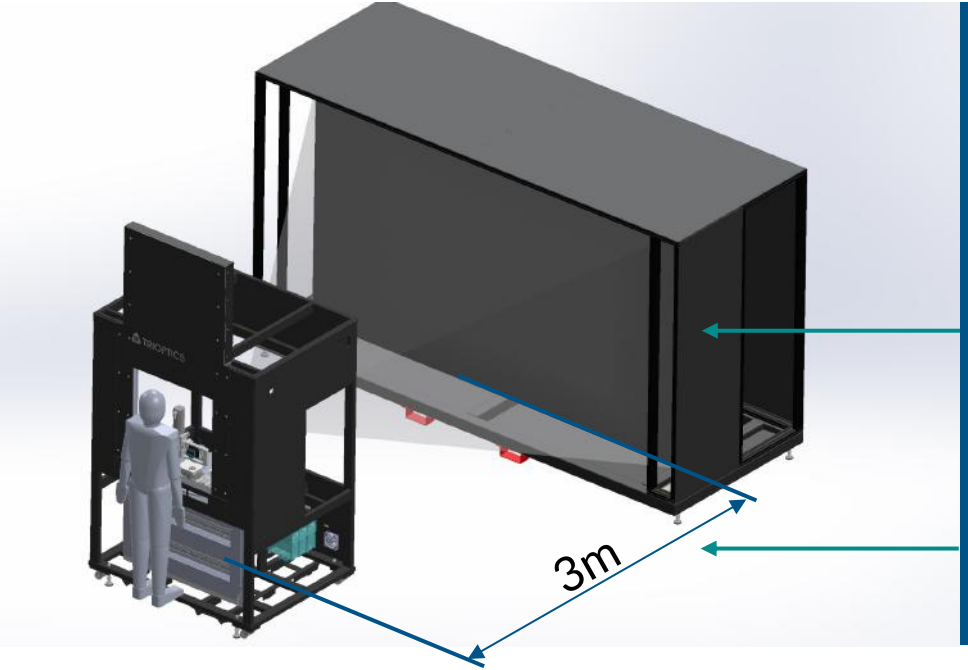
- Accuracy = ±55 arcsec (±0,015°)
- Speed: > 60°/sec





2-axes Gimbal System

LiDAR Post-assembly- reflectivity chart test



Post-assembly test equipment for automotive LiDAR

Adjustment options:

- Custom designed chart w/ different reflectivities (size: 3,5m x 2m)
- 3 axes adjustment
  - radial (z) = ± 2,5mm
  - Rx, Ry = ± 2° (± 0,02° accuracy)

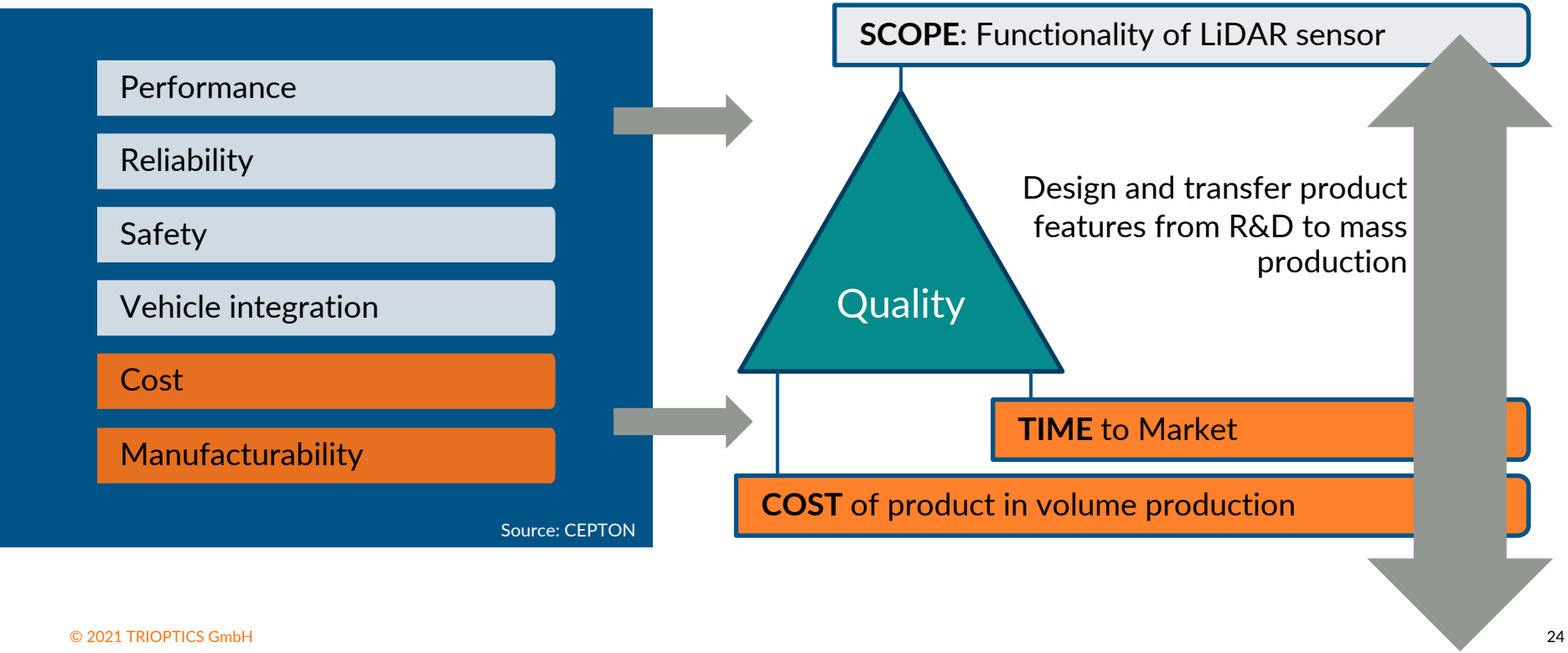
- 2 axes Gimbal system for fast and accurate sensor positioning

LiDAR Post-assembly- focus test

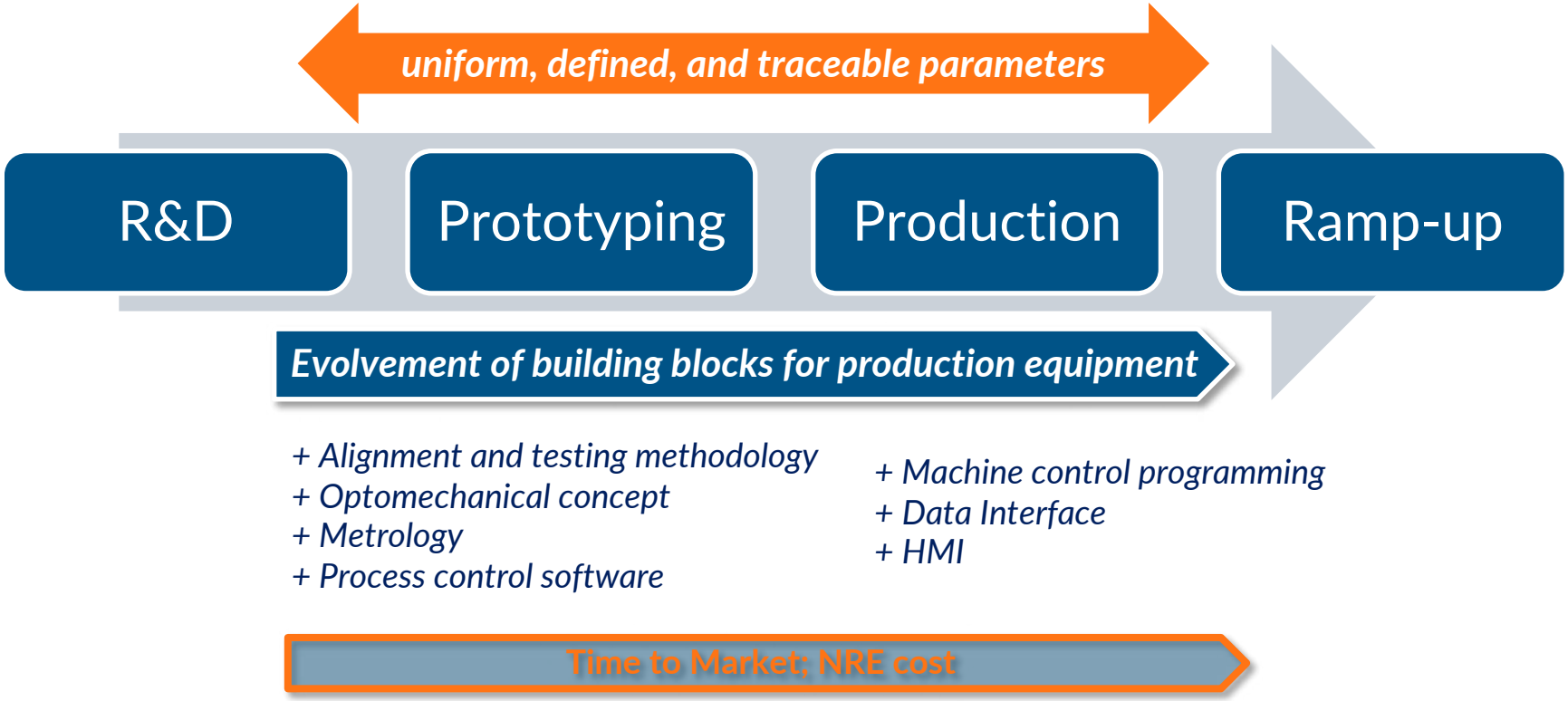
Post-assembly test equipment for automotive LiDAR

- Remeasure focus position (z)
- Remeasure decentering (x, y)
- Remeasure tilt (Rx, Ry)

Foundations for Automotive LiDAR



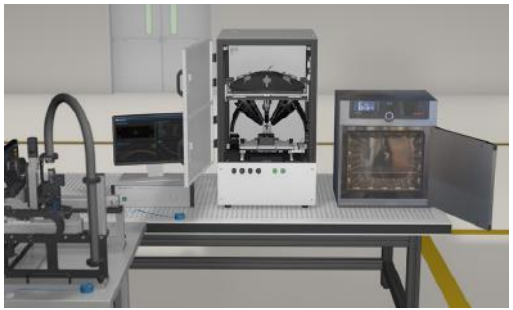
From Lab to Fab: one process across scales



From Lab to Fab: one process across scales

uniform, defined, and traceable parameters

R&D | Prototyping | Production | Ramp-up



Summary

*Begin with an end in mind** … consider manufacturability for mass production early in the design process of your LiDAR product.

*Be proactive**… *d*evelop the alignment and test methodology in parallel with sensor design; apply and evolve the same building blocks to your manufacturing process from laboratory to production to reduce NRE costs and shorten time to market.

*Think win-win** … work with the experts in a timely manner to avoid costly mistakes and redesigns; help yourself and your partners deploy the appropriate technology at the right time.

*Stephen R. Covey: The 7 Habits of Highly Effective People

Contact and more information

Booth at the DVN Conference

TRIOPTICS Website - Automotive:
https://trioptics.com/markets-solutions/automotive/

TRIOPTICS Website – ProCam Products:
https://trioptics.com/products/procam-camera-modules-active-alignment-and-testing/

TRIOPTICS

See the Difference