Fantastic weld seams and how to find them

for a better weld

seam tracking · process monitoring · seam inspection

EPIC
European Photonics
Industry Consortium

Agenda

- **Some figures**
- **Some tasks**
- **Some applications**
- **Some solutions**

Car sales in Europe 2021
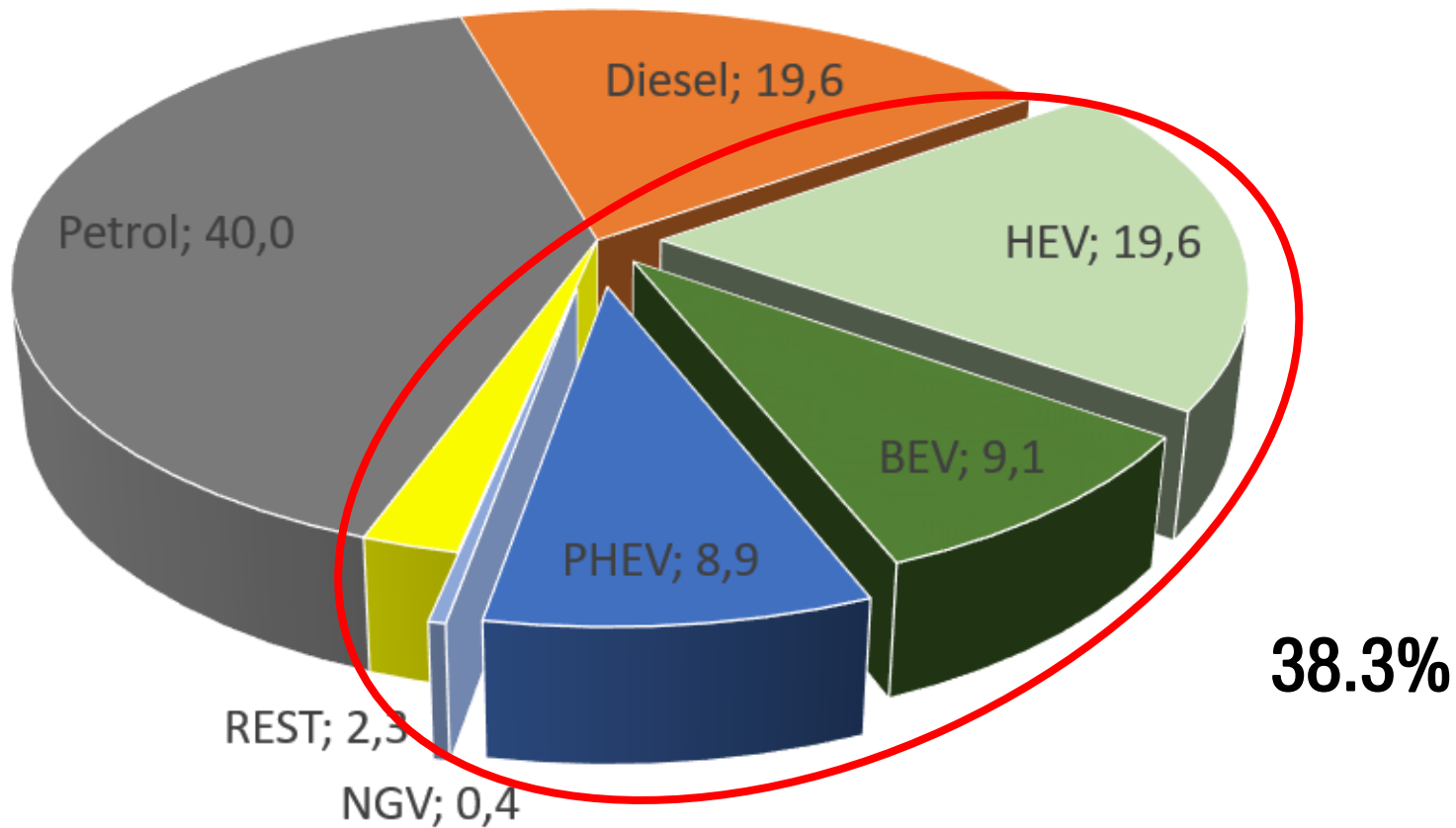
The future has arrived!

38.3%

Source: ACEA

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TESLA announces 3 TWh by 2030 just for TESLA

Pictures TESLA internet

the future is always bright
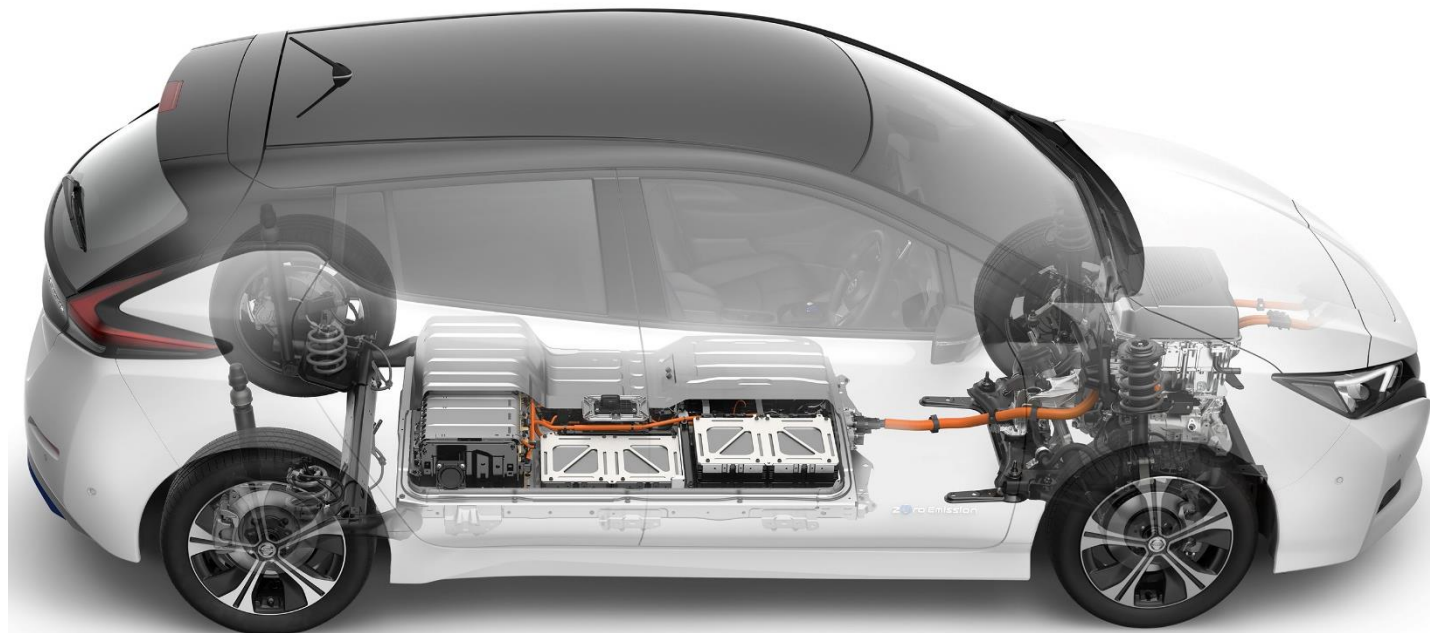
18650

4680

3.0 TWh

241.545.893.720

33.333.333.333

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the future is always bright

3.0 TWh

New CARS   37.500.000

@ 80 kWh per
vehicle

Picture NISSAN

Battery development

Ø 80 kWh per vehicle

Type 2170
~ 8,800 wire tabs
for 4460 batteries

Type 4680
~ 1,800 connections
for 960 batteries

Process influencer

laser: power,
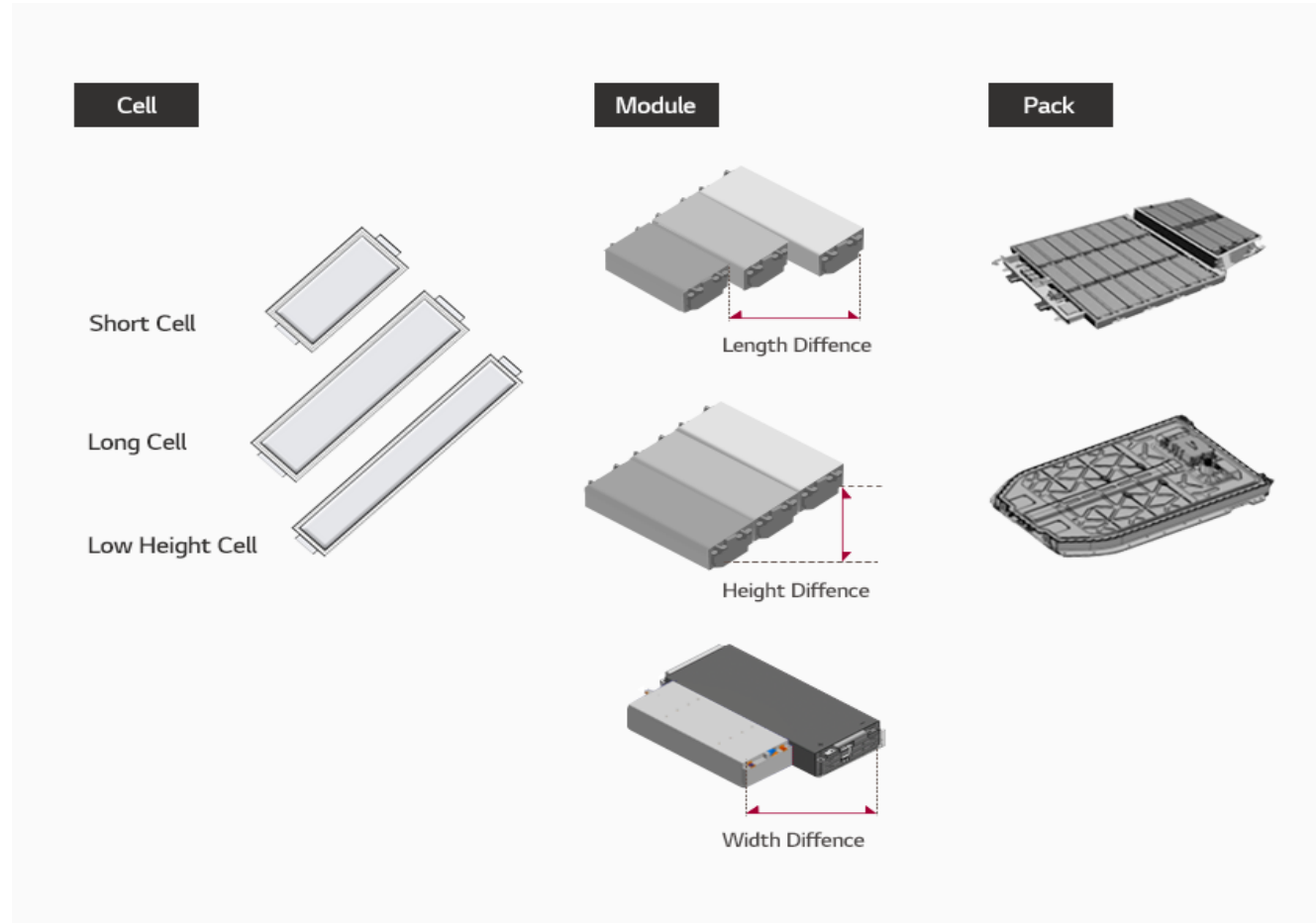beam quality

optics: focal shift,
contamination

material: alloy,
surface, pollution

part: geometry,
clamping

Process monitoring

Process control

Quality assurance

motion system:
speed, positioning

Applications general

Laser welding applications along the battery process chain and the electric motor
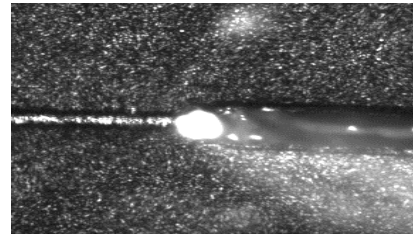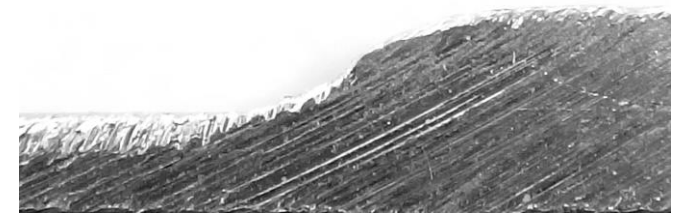

Pictures: courtesy of scansonic and BMW

PRE

IN

POST

seam tracking

process monitoring

seam inspection

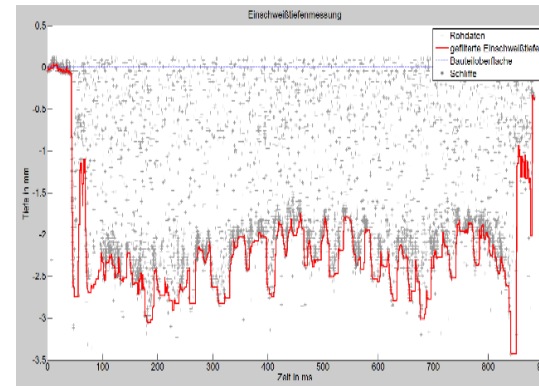# Applications battery cell

cylindrical
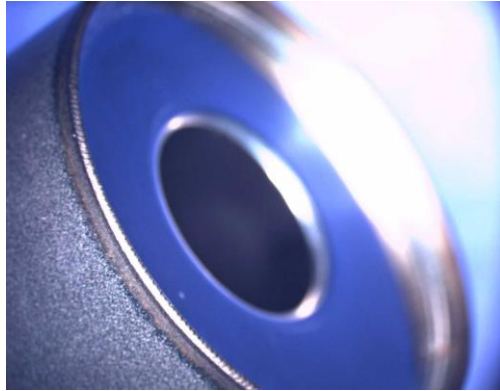
prismatic

seam tracking – OCT

depth measurement – OCT

process monitoring – WELDCHECK

PFO 3D: Laserbearbeitung
in drei Dimensionen
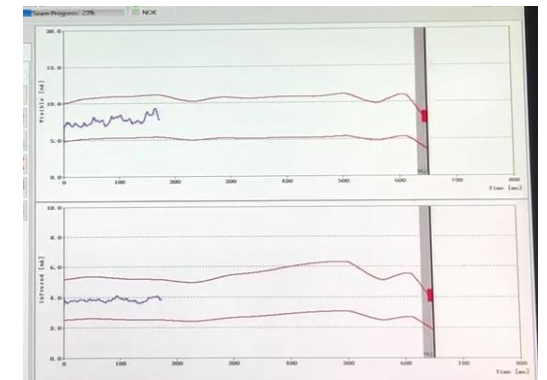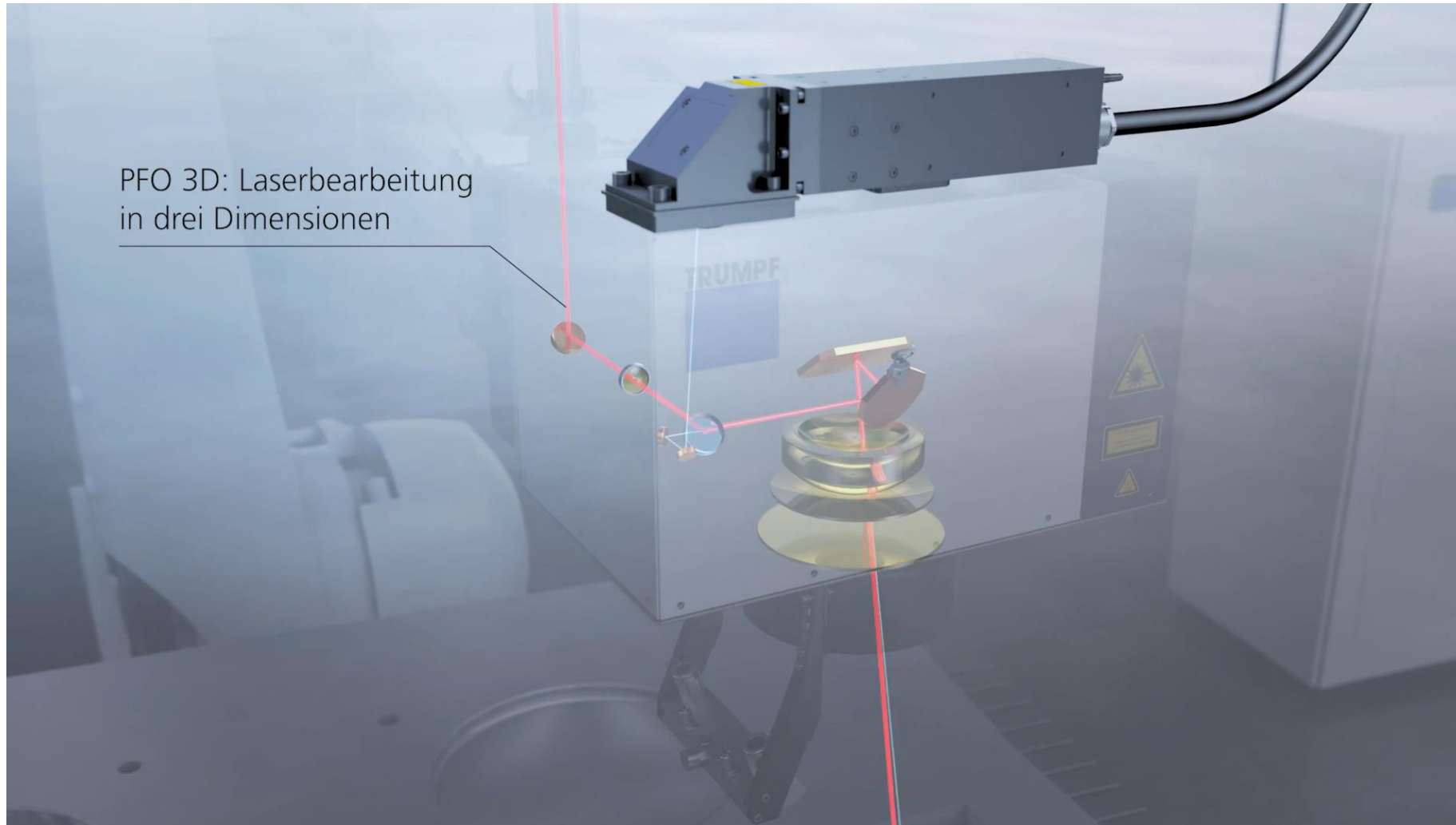
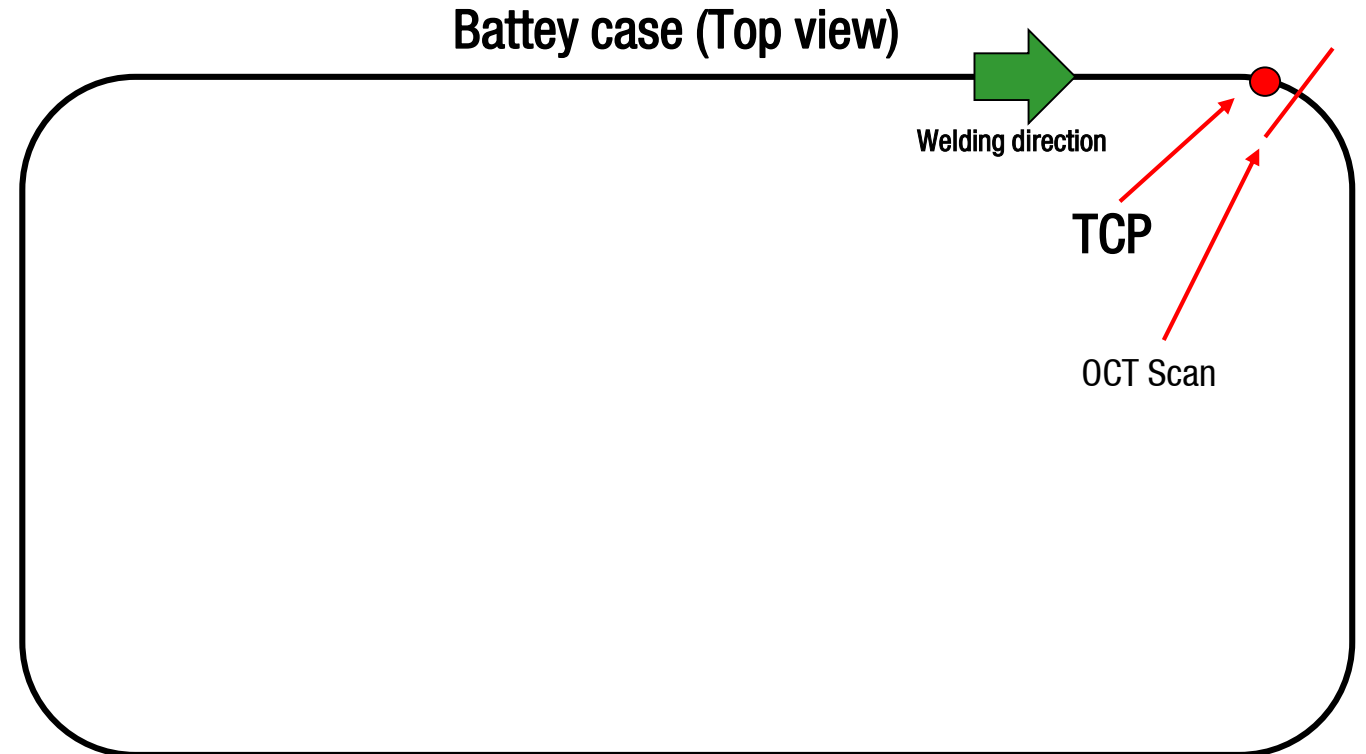## Step 2

- Real time seam tracking during welding process
- Real time correction of TCP in X– and Y–direction
- OCT measurement 2 mm ahead of TCP
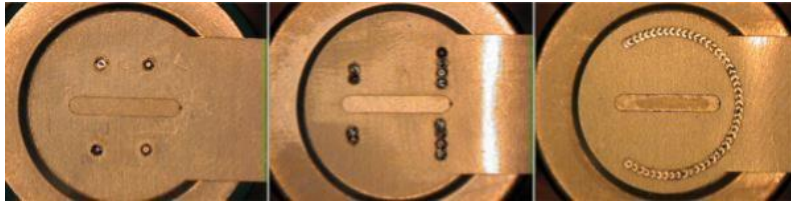- OCT scan lines are following the geometry of the battery case

Battey case (Top view)

Welding direction

TCP

OCT Scan

OCT with high speed camera

4000 fps – 160 x slower

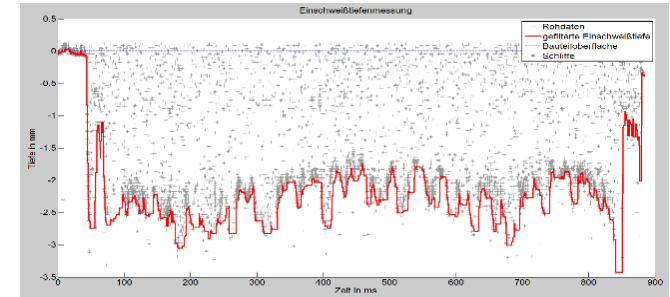# Applications cell contacting and moduling

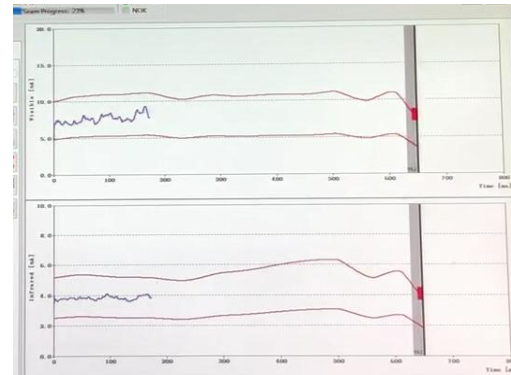## can tab connection

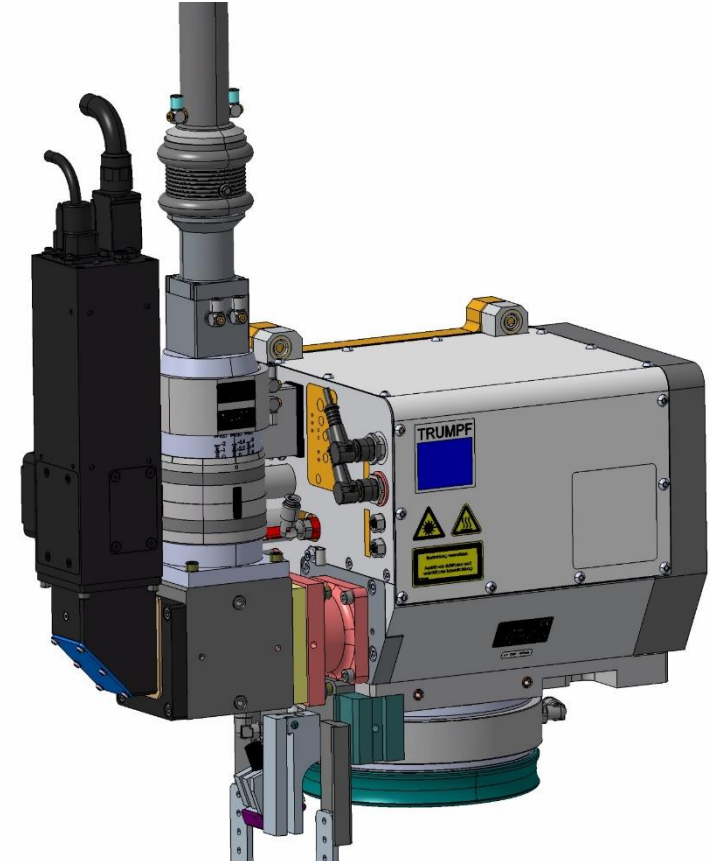

busbar welding

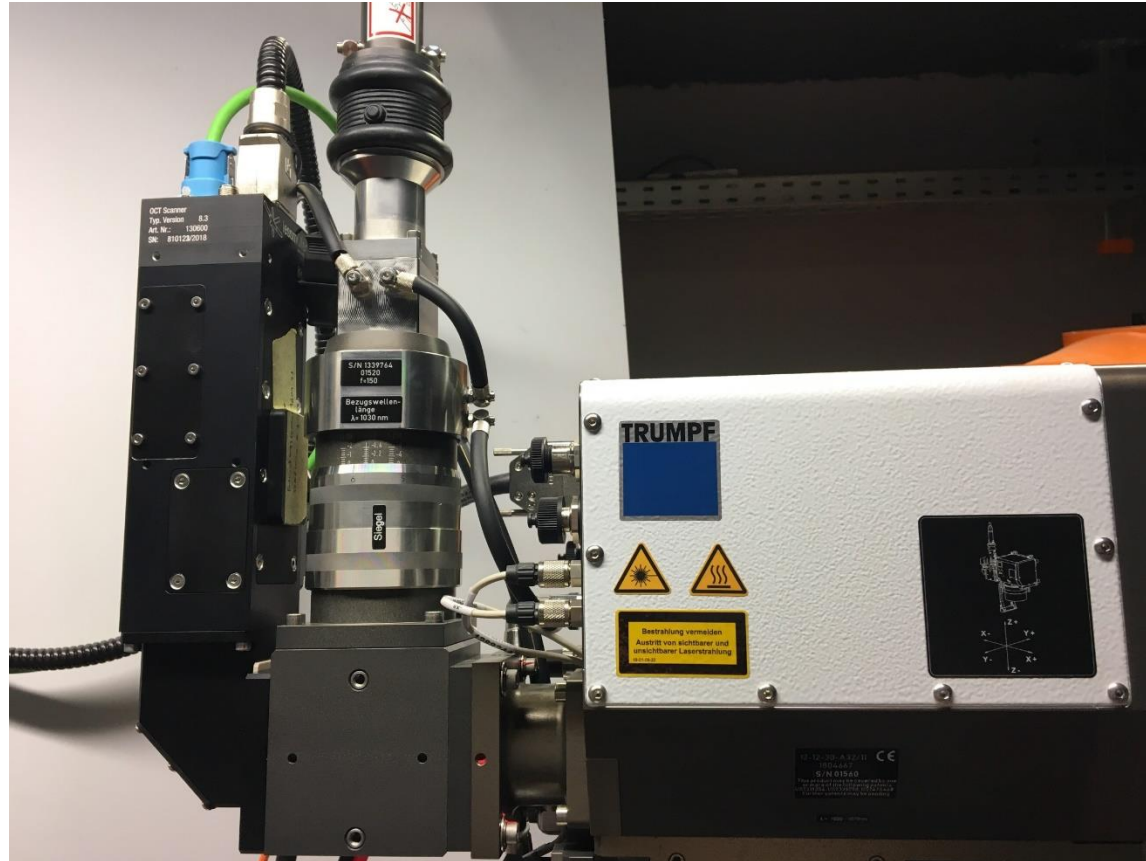**positioning– OCT**

depth measurement – OCT

process monitoring – WELDCHECK
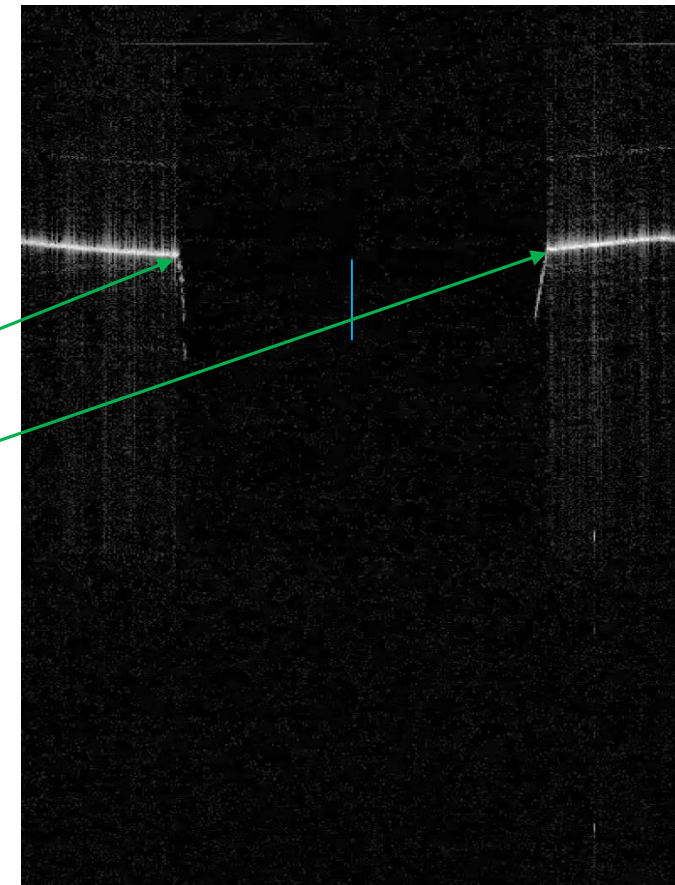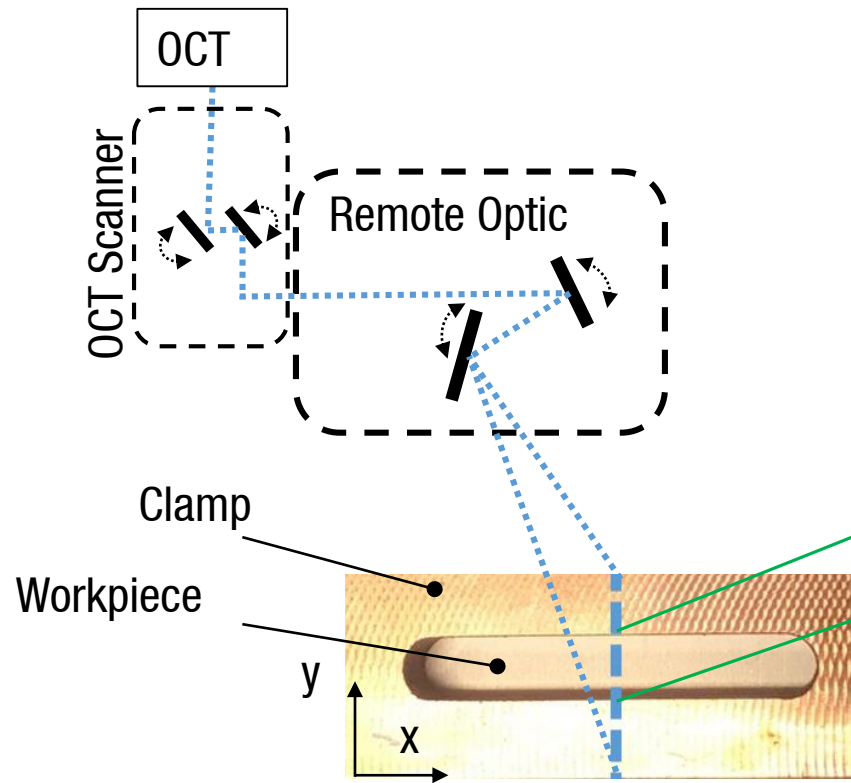

seam inspection – OCT
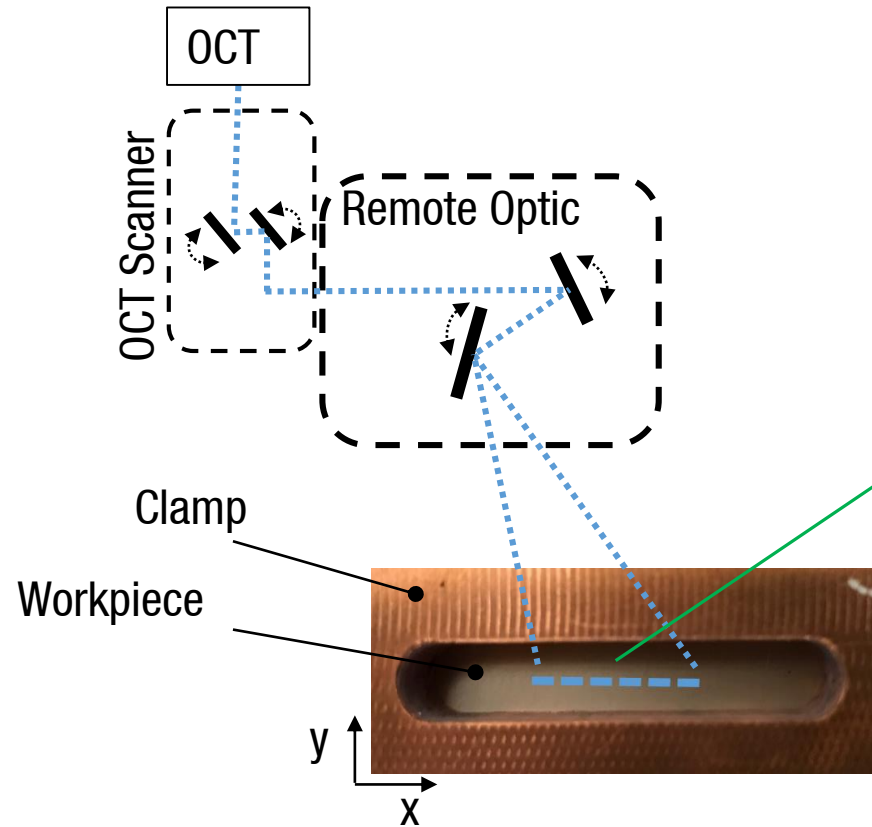
OCT set up

PFO 33 with OCT Scanner attached

OCT for positioning – Clamp–Detection

- Fast and reliable positioning via OCT.
- Accuracy < ±50 µm.

Source: Marius Schwarz, Battery Systems, Bad Nauheim, 2021

OCT for focus control

OCT

OCT Scanner

Remote Optic

Clamp

Workpiece

y

x

Fast and reliable focus control via OCT.
Accuracy < ±25 µm

Signal of the work piece

Δz

$z = 0$
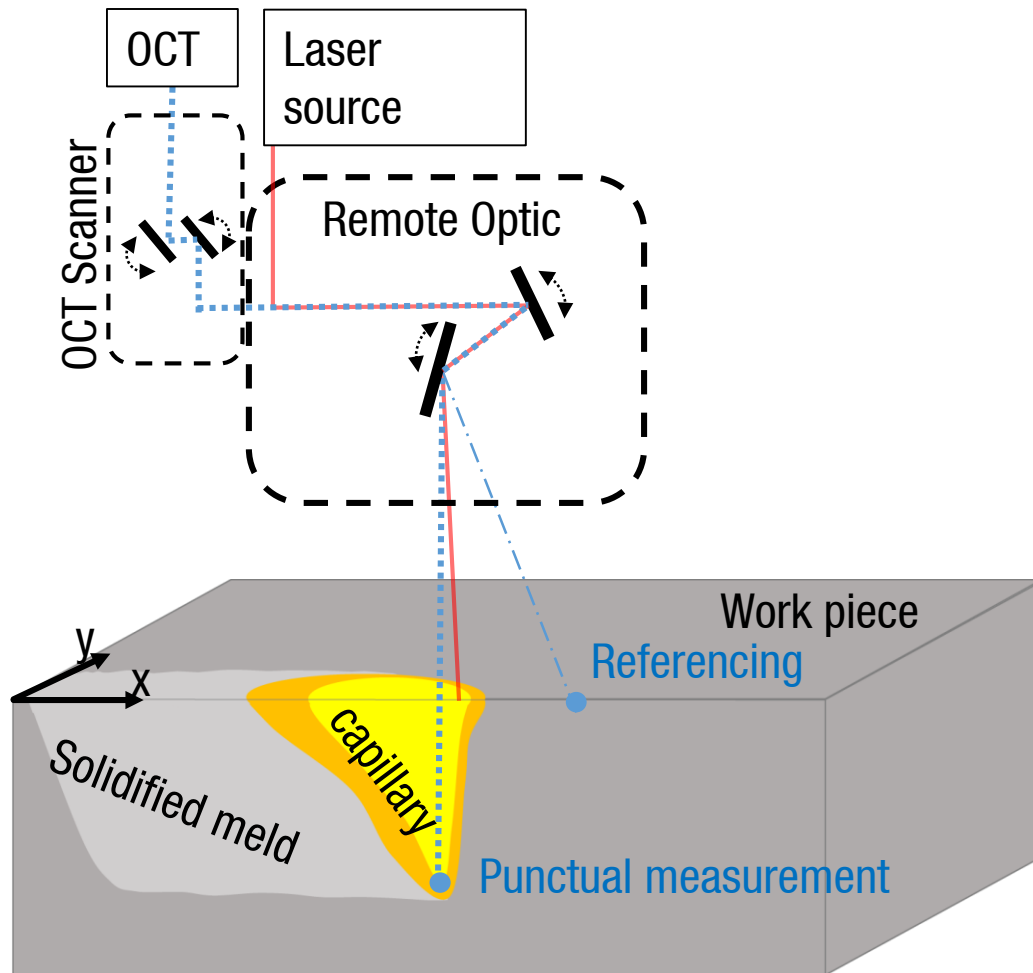
r

z
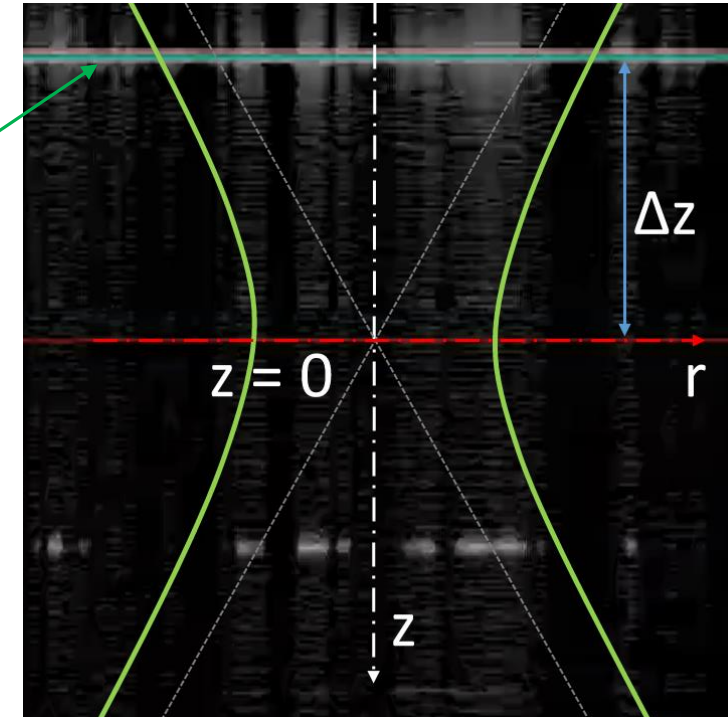
Focus position of
processing laser

Source: Marius Schwarz, Battery Systems, Bad Nauheim, 2021

# In–process measurement of capillary depth

- Scanner–based OCT System enables various measurement modes.
- Especially with very short processing times the inline capillary depth measurement is predestined to monitor the process.
- Line Scan and punctual measurement of the capillary depth can be used for inline–monitoring.

Lin et. al., 2017

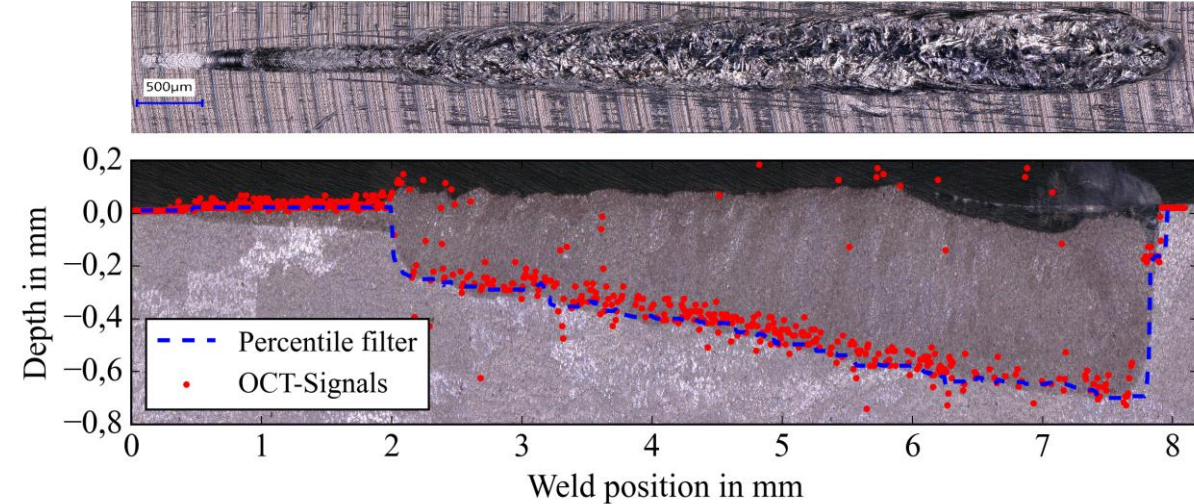Source: Marius Schwarz, Battery Systems, Bad Nauheim, 2021

Capillary Depth Measurement – Punctual measurement

Offset x

Referencing

Punctual Measurement

Welding direction
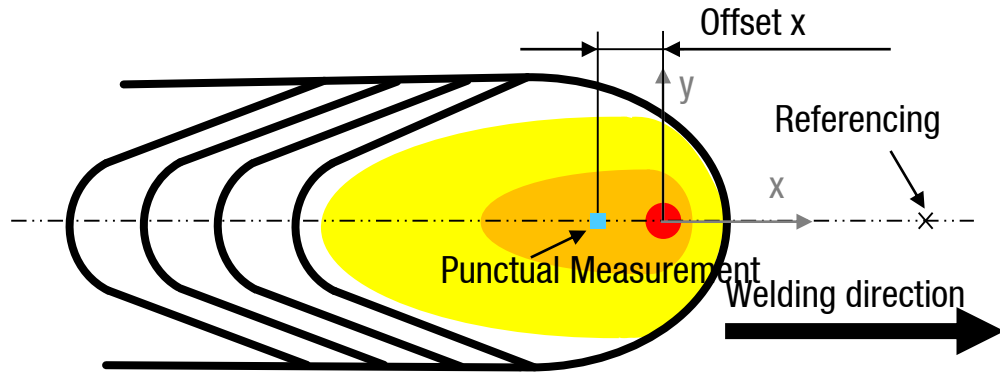
Exemplary result of punctual capillary depth measurement

Copper 0.2 mm – Aluminum 0.4 mm
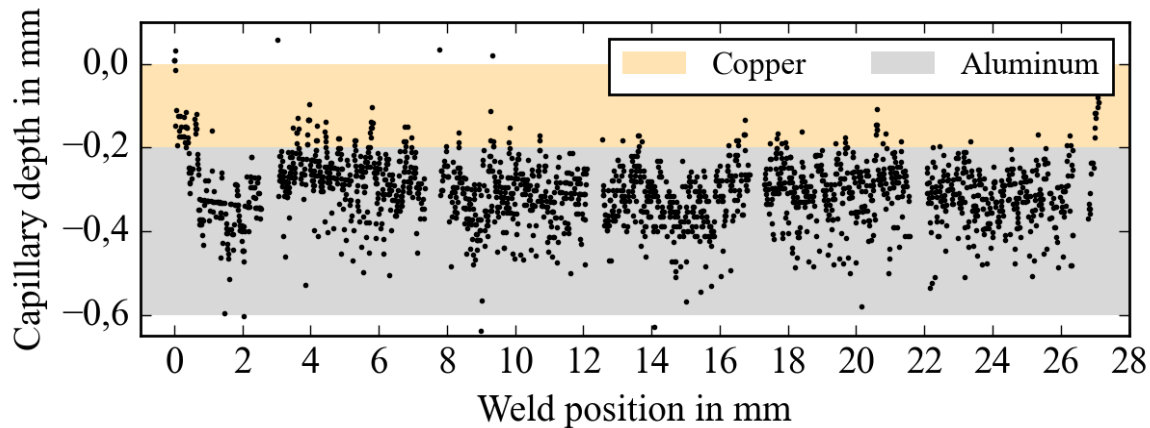
OCT Signal aquisition at the transition from HDW to DW
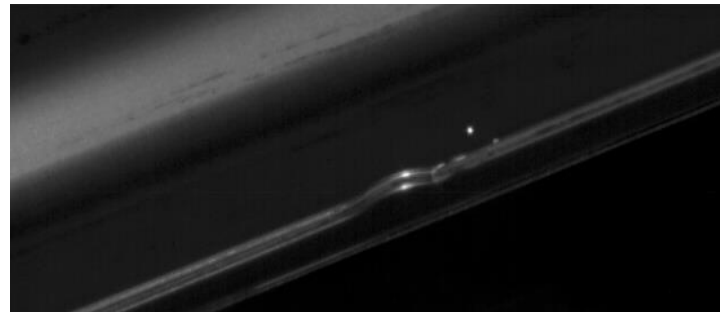Aluminium, linear laser ramp 0.5 - 2 kW, 30 m/min

- Good congruence between punctual capillary depth measurement and real welding depth by applying percentile filters!

Source: Marius Schwarz, Battery Systems, Bad Nauheim, 2021
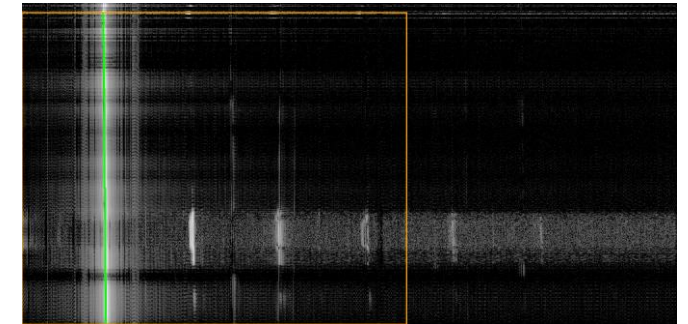
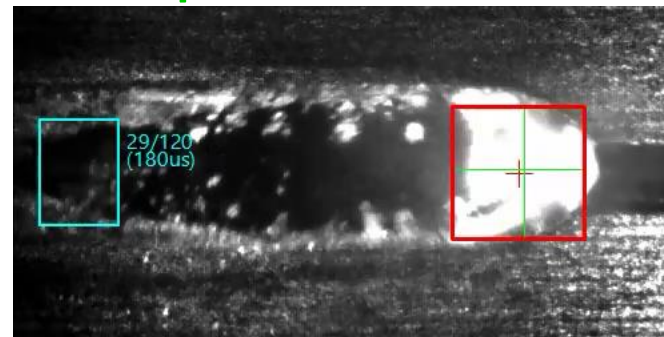# Applications battery packaging
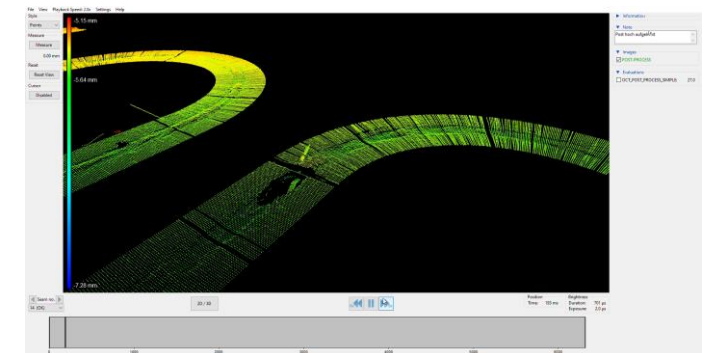
battery packages / systems

seam tracking– OCT

depth measurement – OCT

process monitoring – seam inspection WELDEYE

29/120 (180us)

seam inspection – OCT

OCT POST measurement & fault detection

scan line

scan line

splash
pore

−X

Z

splash

pore

Image position:
(249; 511) pixel
(2.81; 5.12) mm
Intensity: 0
Distance:
50.0 pixel
(-50.0; 0.0) pixel
0.56 mm
(-0.56; 0.00) mm
Angle:
180.00 deg

welding direction x
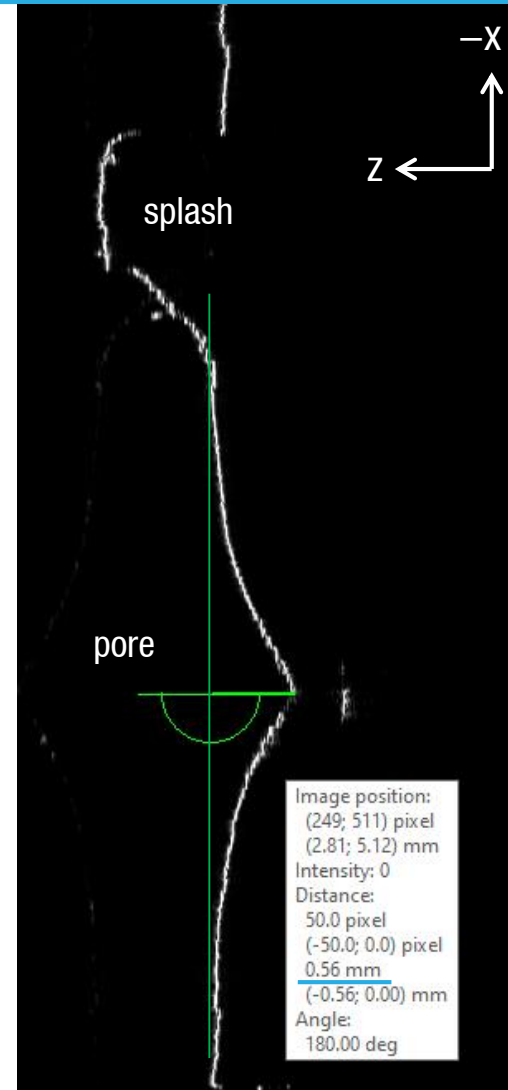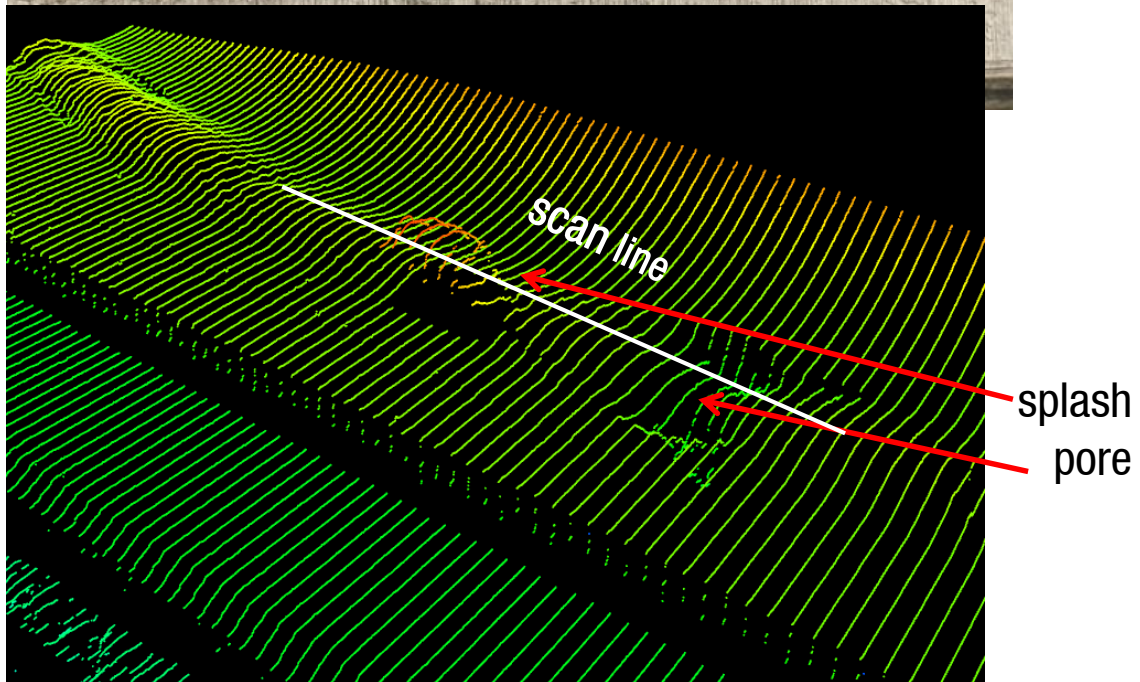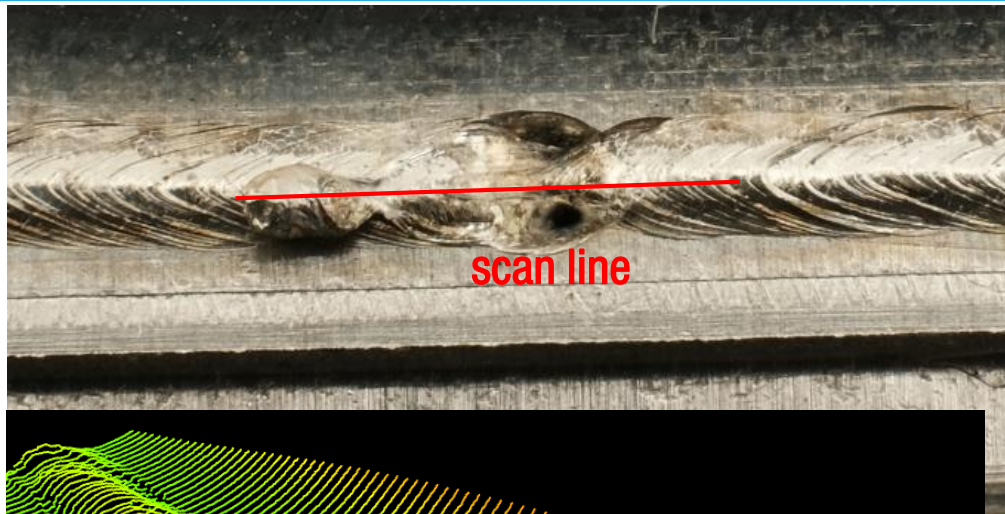
OCT scan line of seam in welding direction

▶ POST: **find faults**

▶ Pore and splash detected in scan

▶ Pore depth > 0.5 mm

▶ Splash height > 0.8 mm

Optics connected with Lessmüller OCT

remote optics

fixed optics

History of Lessmüller Lasertechnik

2022 — OCT 250 kHz and stand alone

2020 — WELDCHECK 4.1
Diode based process monitoring GEN 4

2015 — OCT and LSO
Introduction of OCT– measurement system
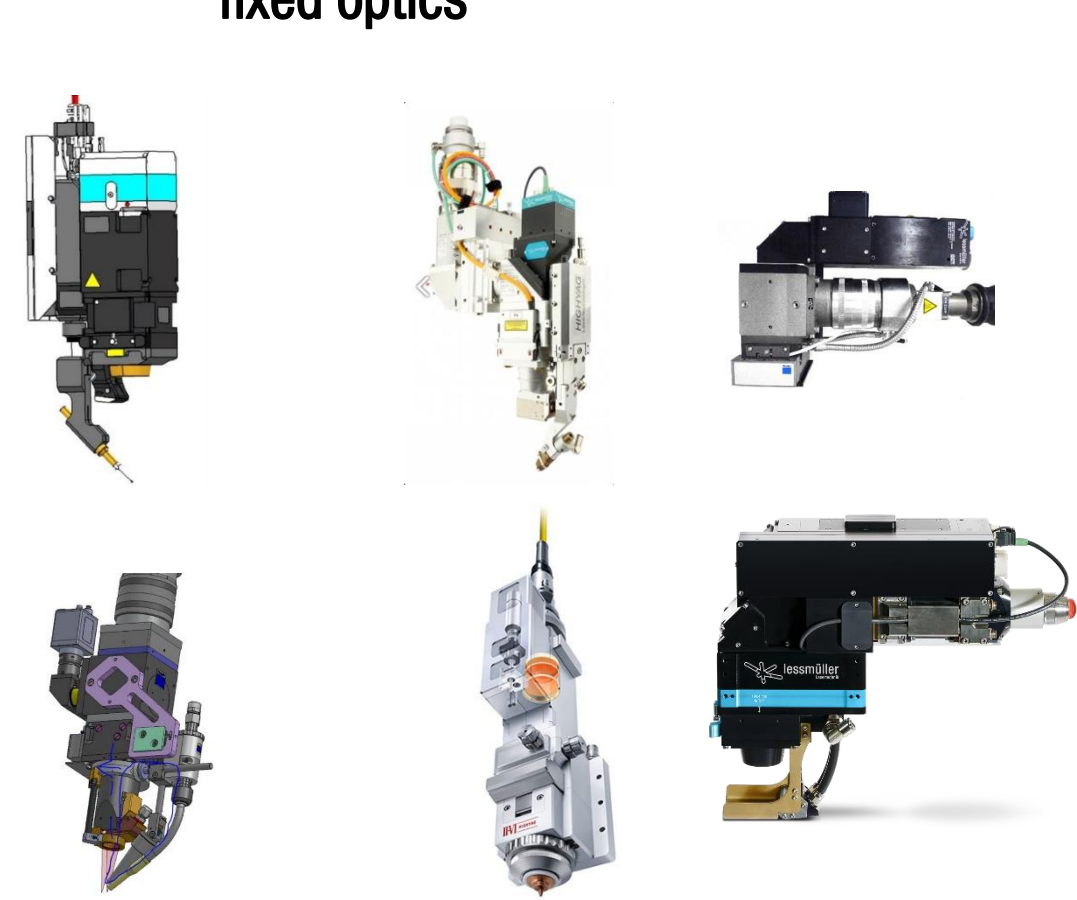and LSO– laser welding optics

2013 — FILLET SCAN
Seam tracking system for remote laser welding

2008 — WELDEYE
Process visualization and quality supervision

1998 — WELDCHECK
Diode based process monitoring GEN 1

1990 — Foundation of the company to commercialize a patent for active stabilisation and optimisation of laser resonators.

Come and visit us!

Hall A5 booth 350

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