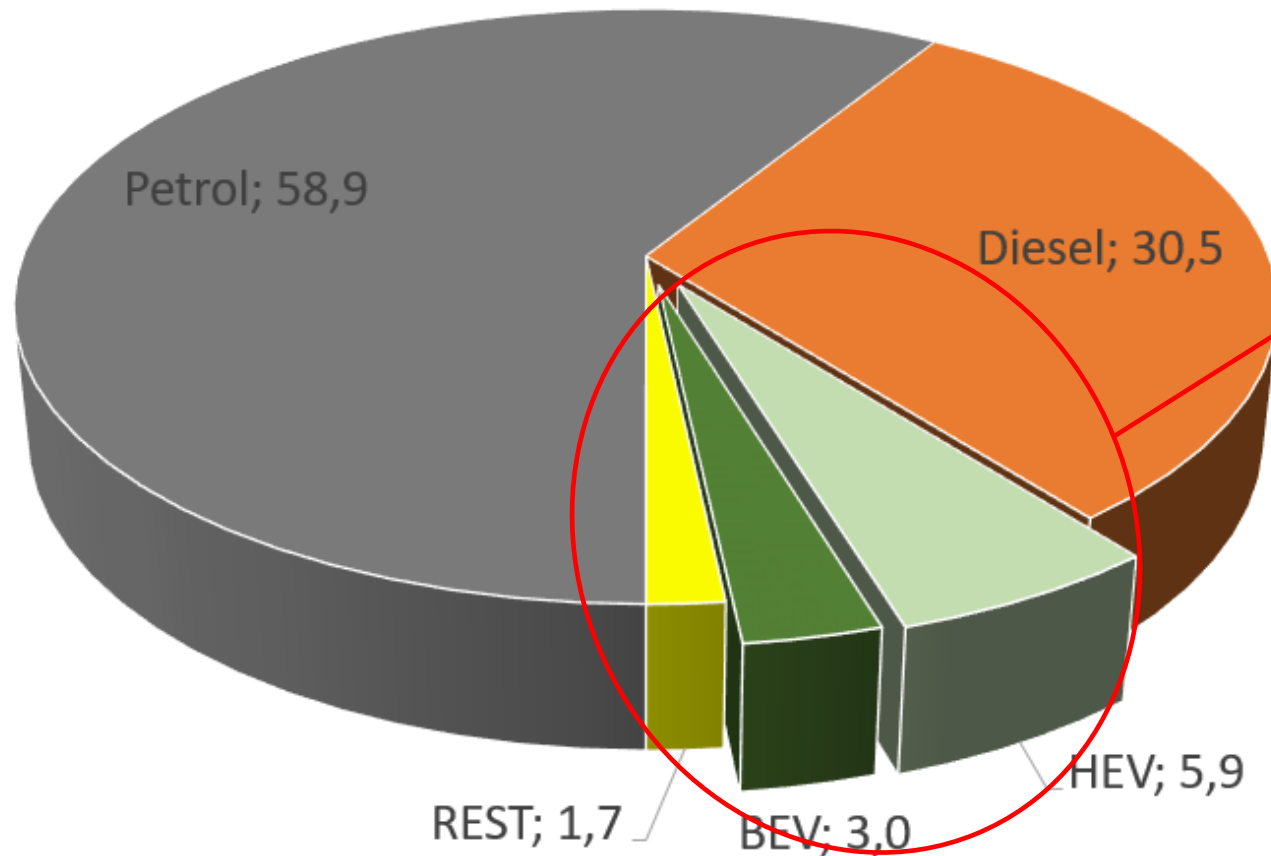


Sensor applications for laser welding in battery production



Car sales in Europe 2019 by type of drive

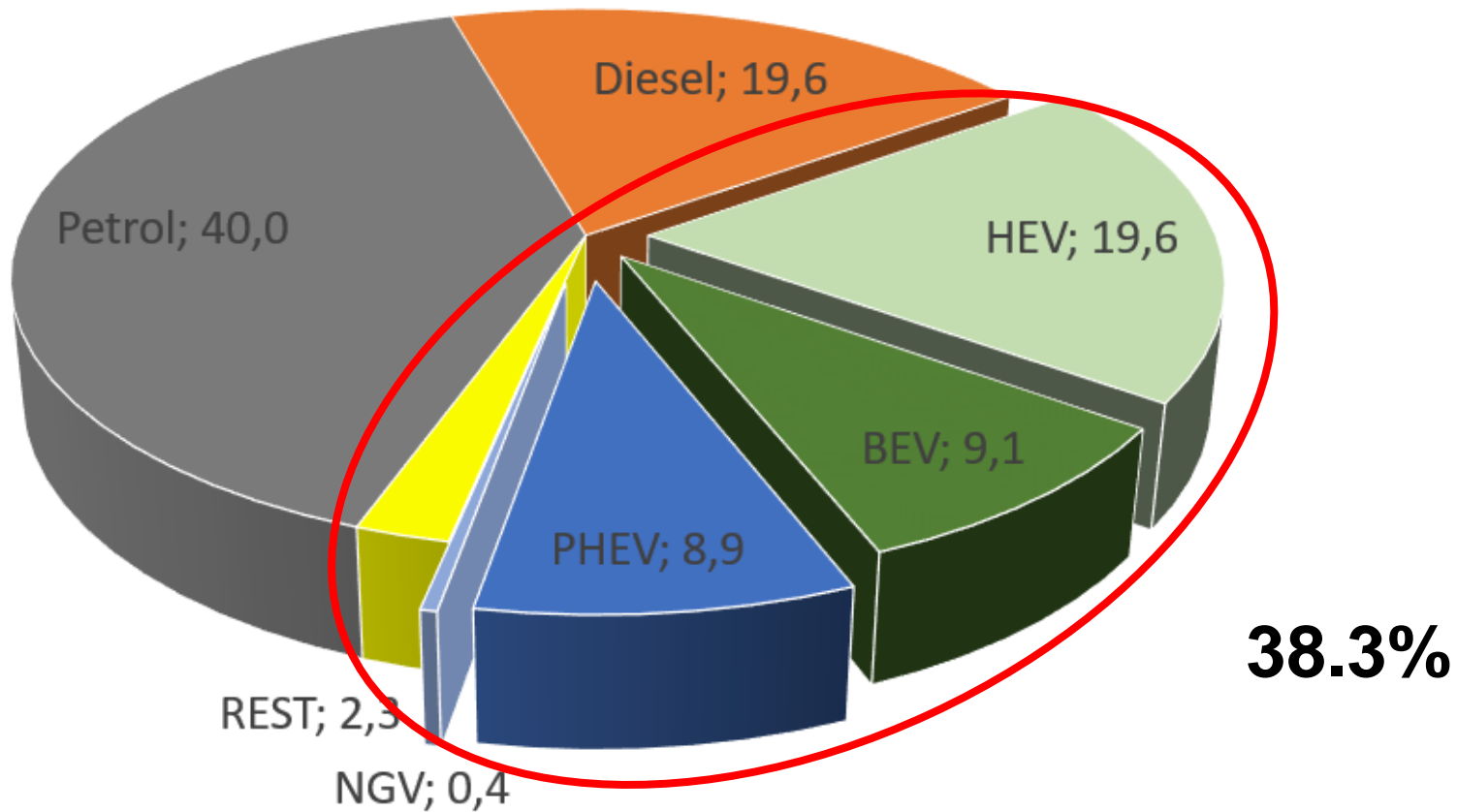


This is what we're talking about in the future!

< 10%

Source: ACEA

Car sales in Europe 2021

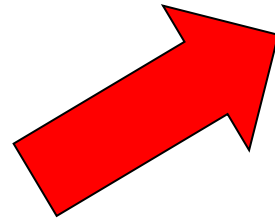


The future has arrived!

Source: ACEA

the future is always bright

Li-ion Battery Cell Capacity Will Quadruple to 1.3 TWh By 2030



Pictures NORTHVOLT internet

the future is always bright

TESLA announces 3 TWh by 2030 just for TESLA



Pictures TESLA internet

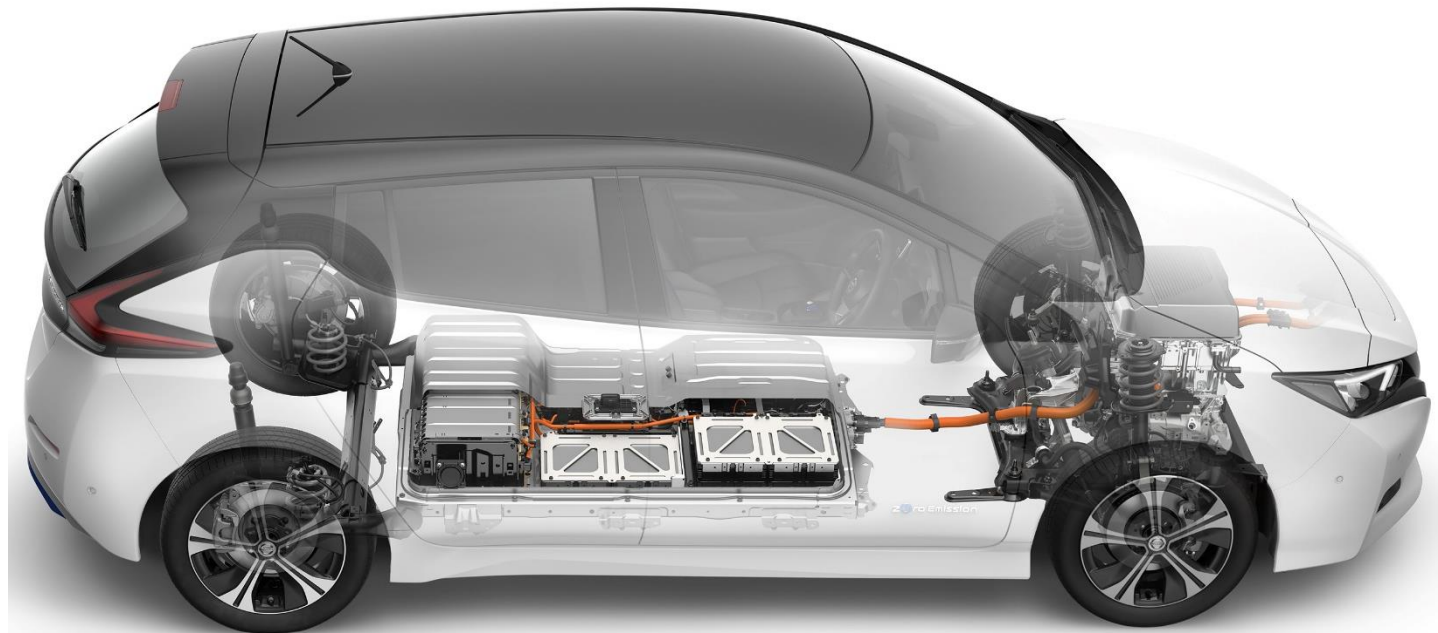
the future is always bright

3.0 TWh

New CARS

37.500.000

@ 80 kWh
per vehicle



Picture NISSAN

the future is always bright



18650

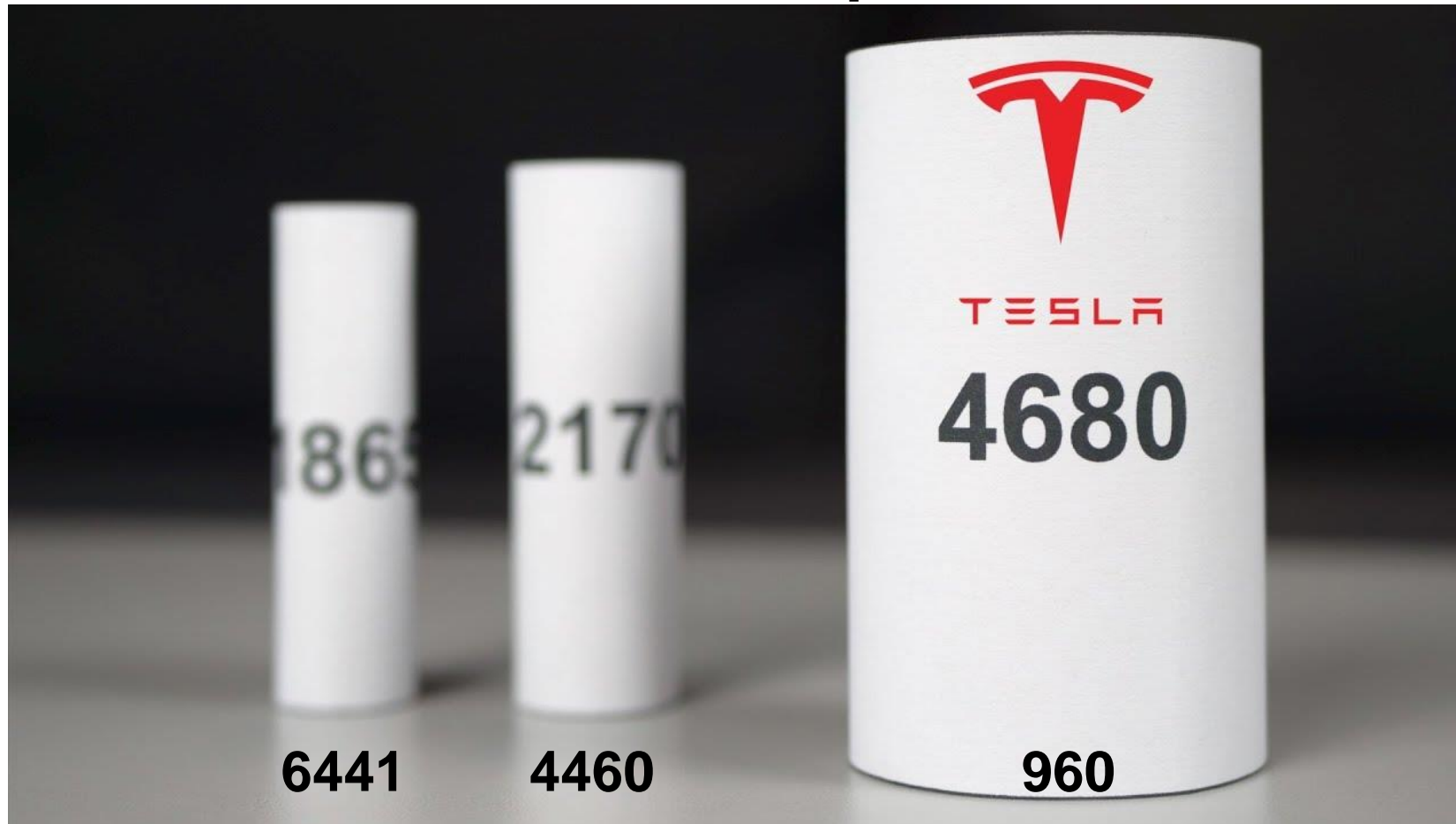


3.0 TWh

241.545.893.720

33.333.333.333

Ø 80 kWh per vehicle



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**

**part:
geometry,
clamping**



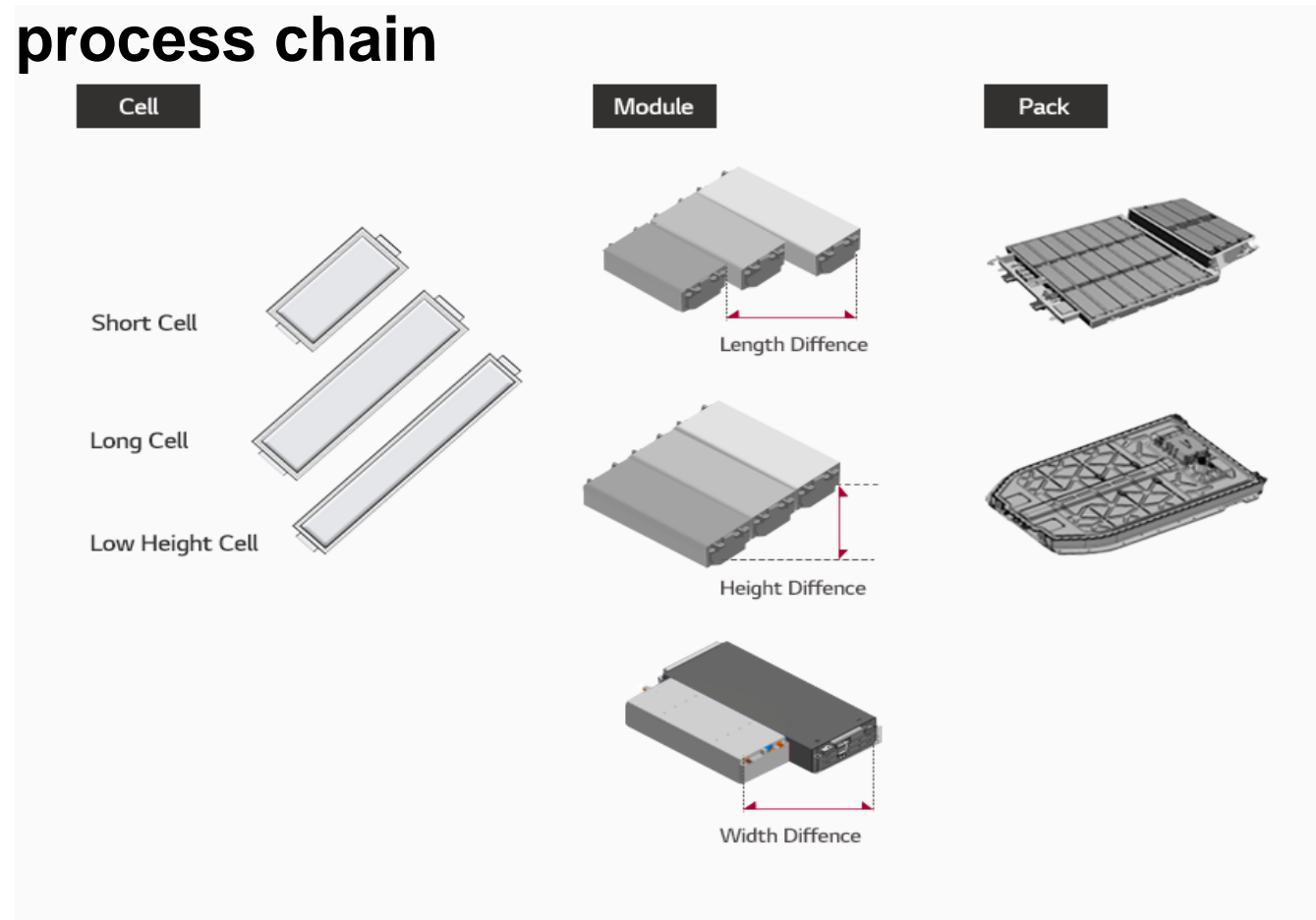
**motion
system:
speed,
positioning**

**optics: focal
shift,
contamination**

**material: alloy,
surface,
pollution**

**Process monitoring
Process control
Quality assurance**

Laser welding applications along the battery process chain



and the electric motor



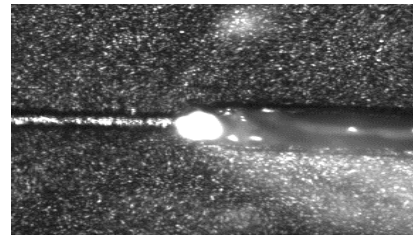
Pictures: courtesy of scansonic and BMW

PRE



seam tracking

IN



process monitoring

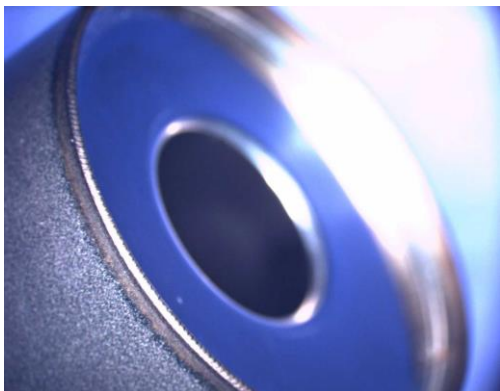
POST



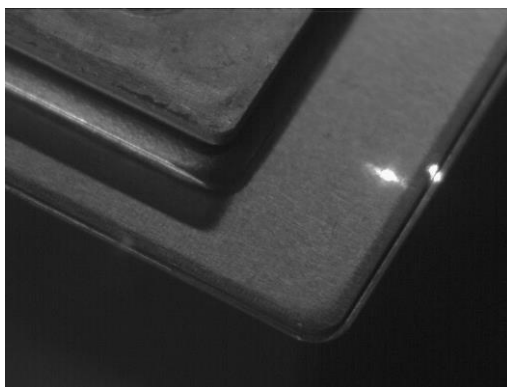
seam inspection

Applications battery cell

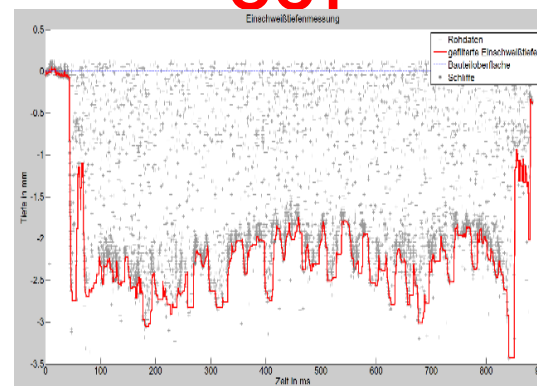
cylindrical



seam tracking -
OCT



depth
measurement -
OCT

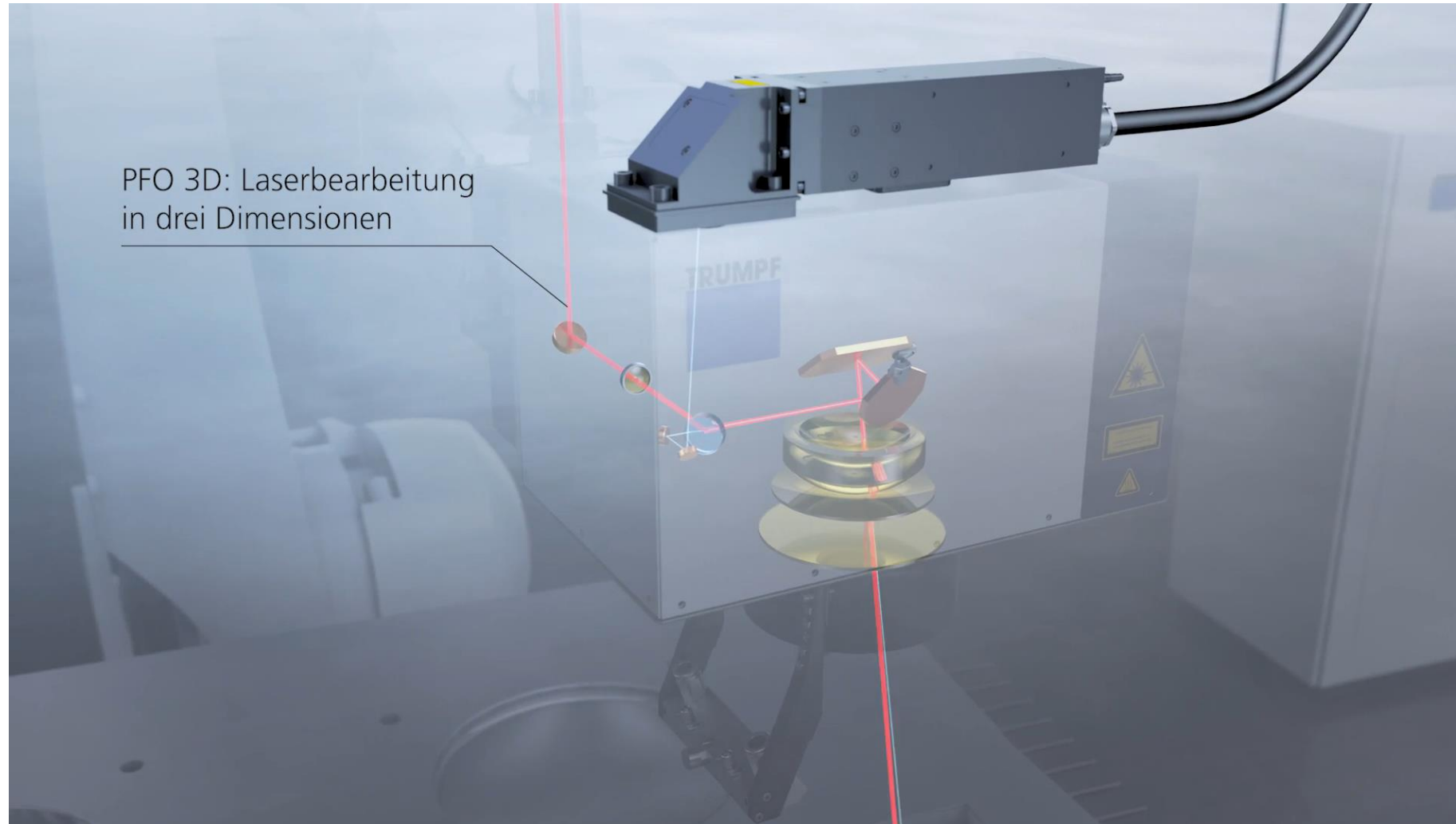


process
monitoring -
WELDCHECK



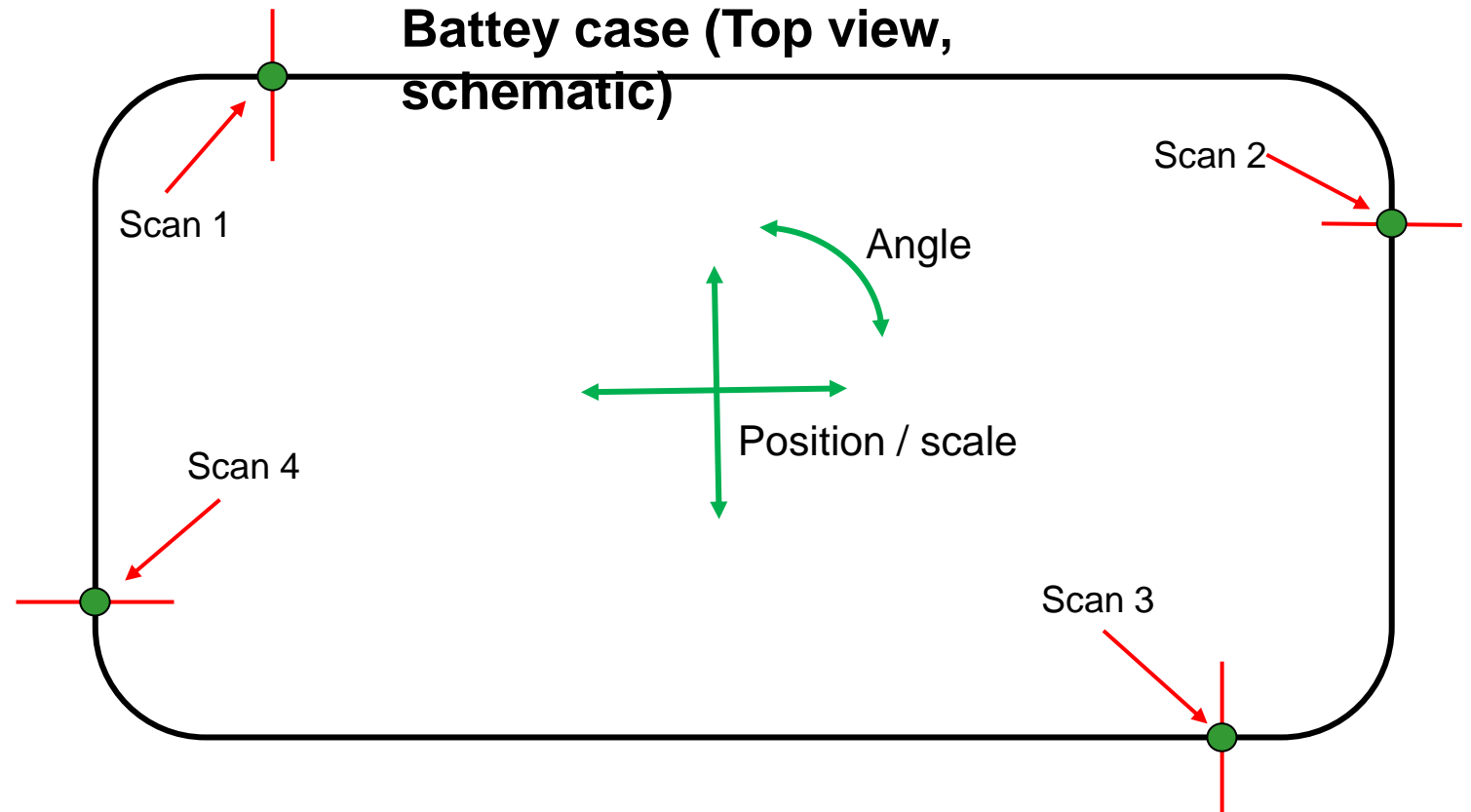
prismatic





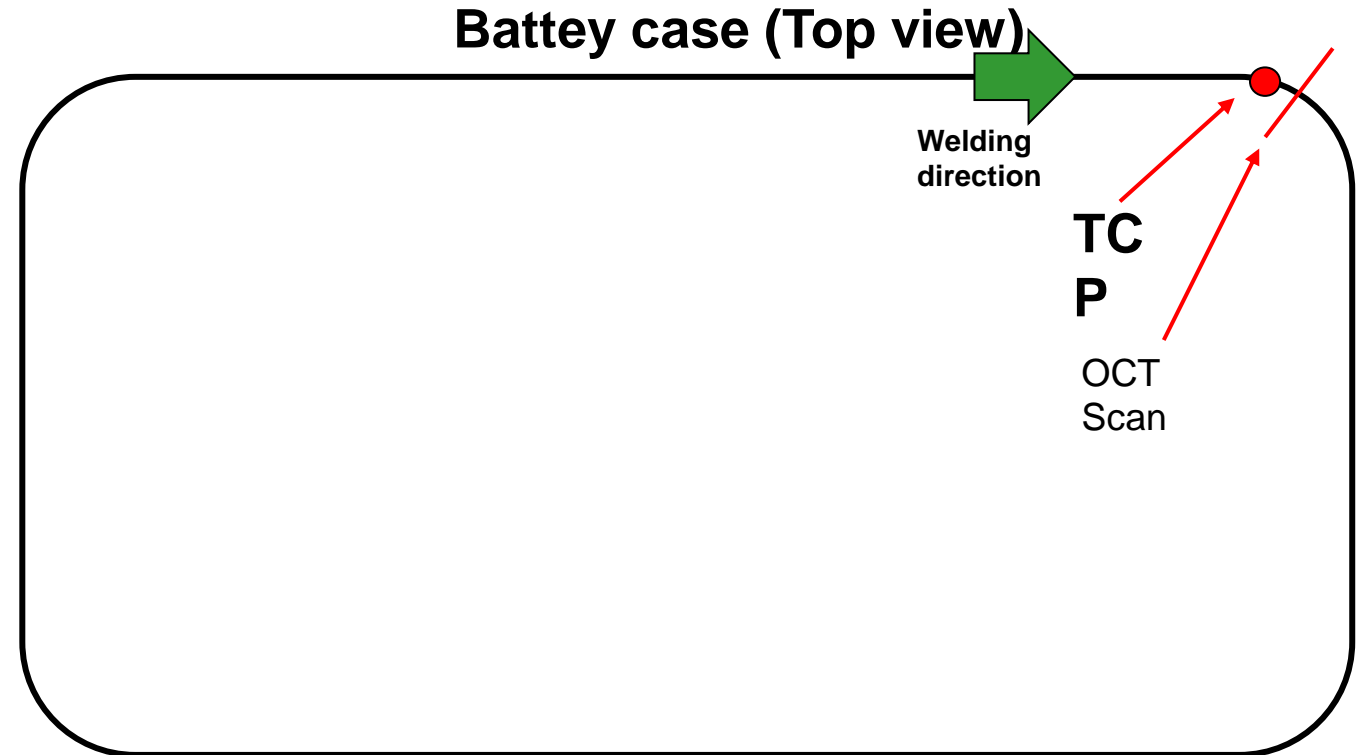
Step 1

- Shape tracking
 - 4 scan lines before welding
- Detection of
 - Position
 - Scale
 - Angle
- Sending correction data to host (δx , δy , θ)



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



OCT with high speed camera

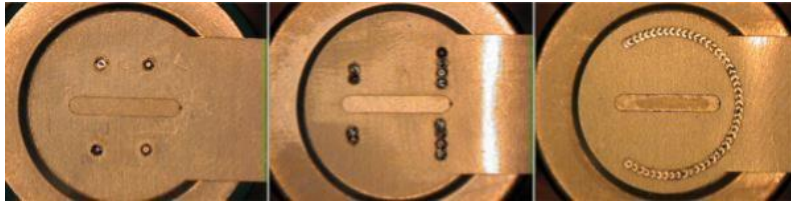


4000 fps – 160 x slower

Applications cell contacting and module assembly

lessmüller
Lasertechnik

can tab connection



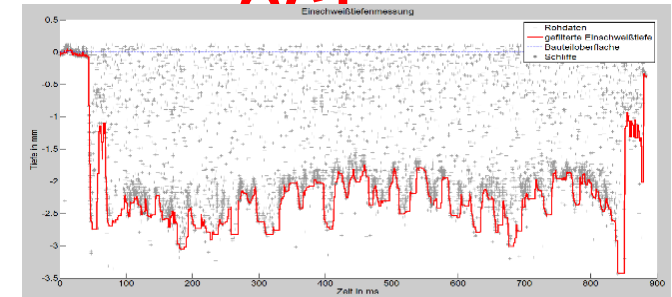
busbar welding



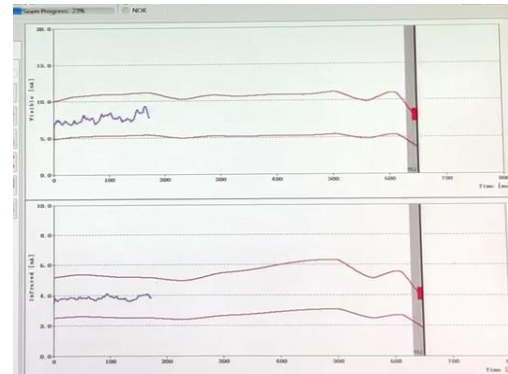
positioning- OCT



depth measurement - OCT



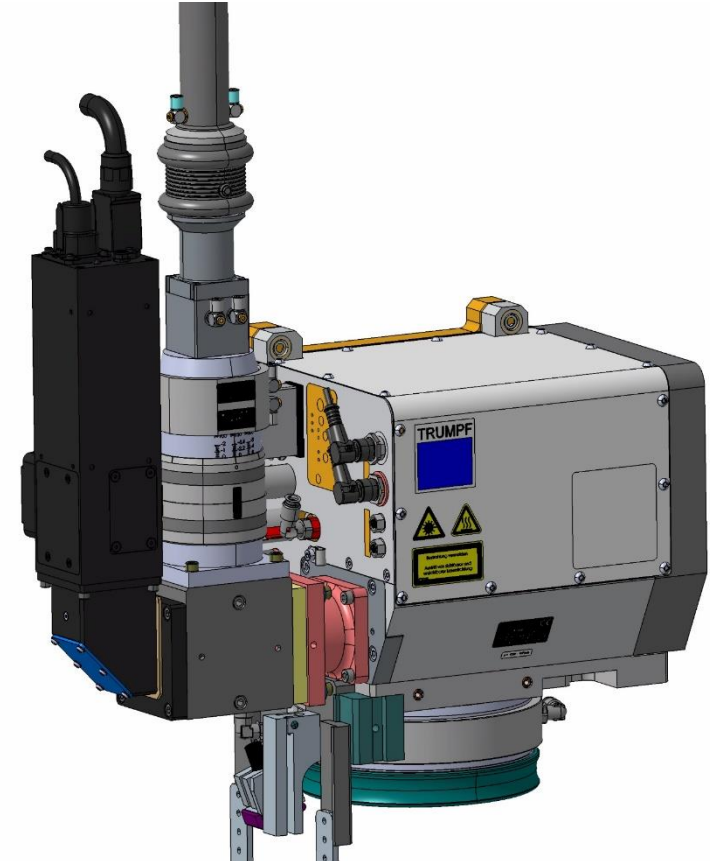
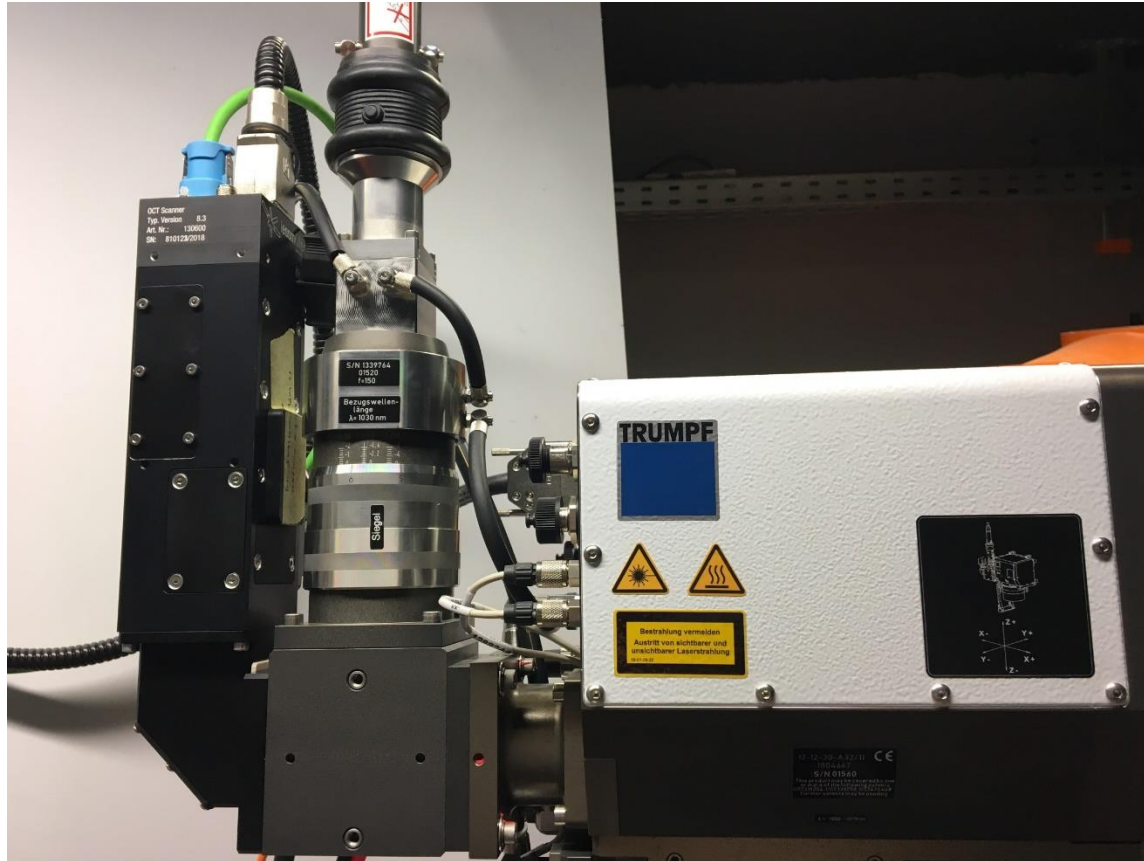
process monitoring -



seam inspection - OCT

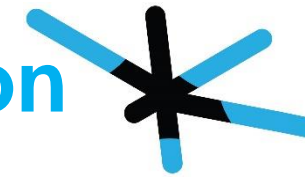


OCT set up

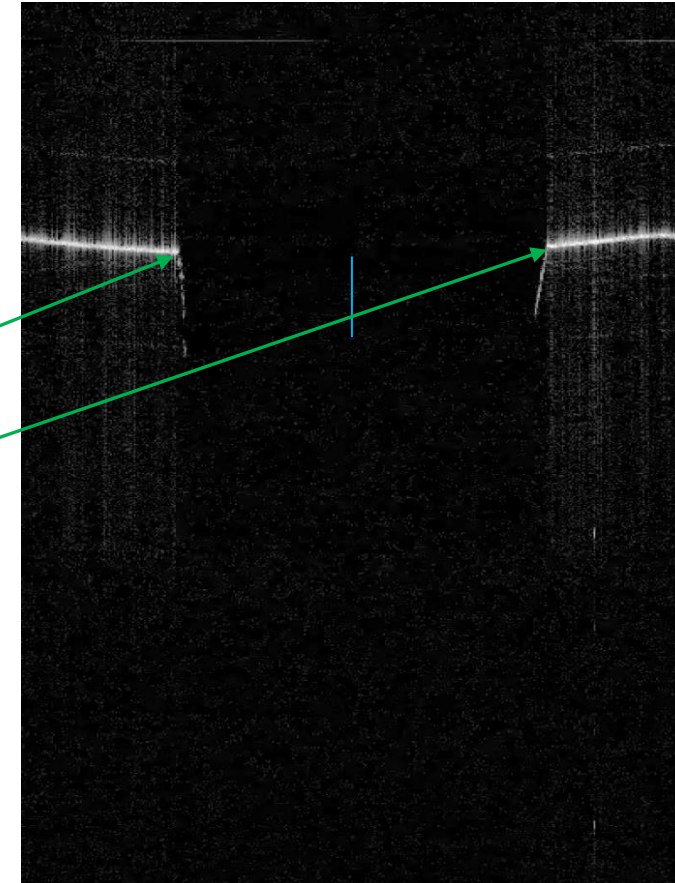
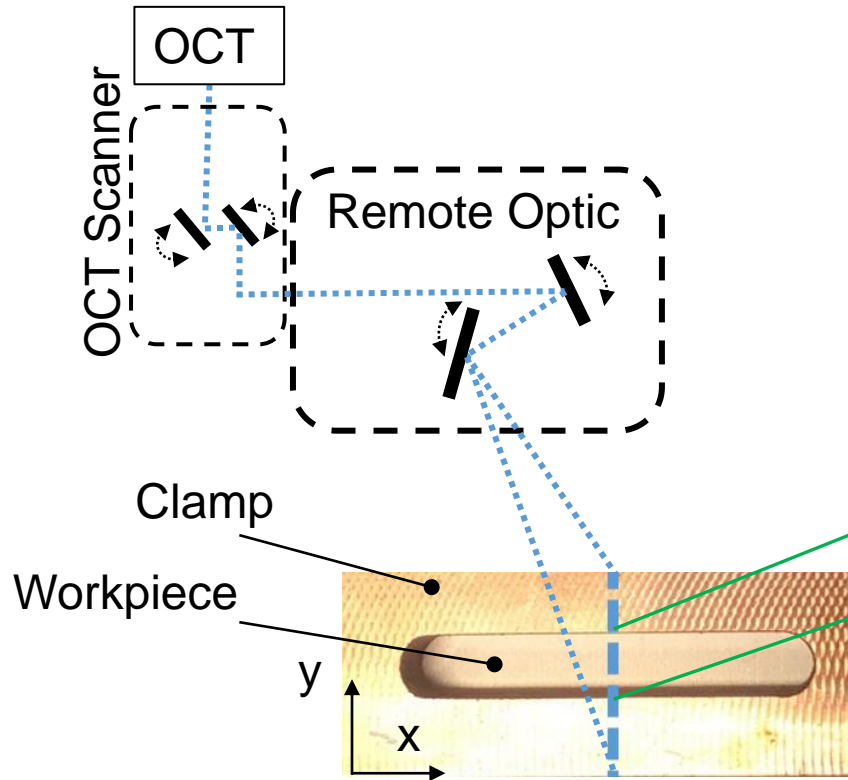


PFO 33 with OCT Scanner attached

OCT for positioning - Clamp-Detection



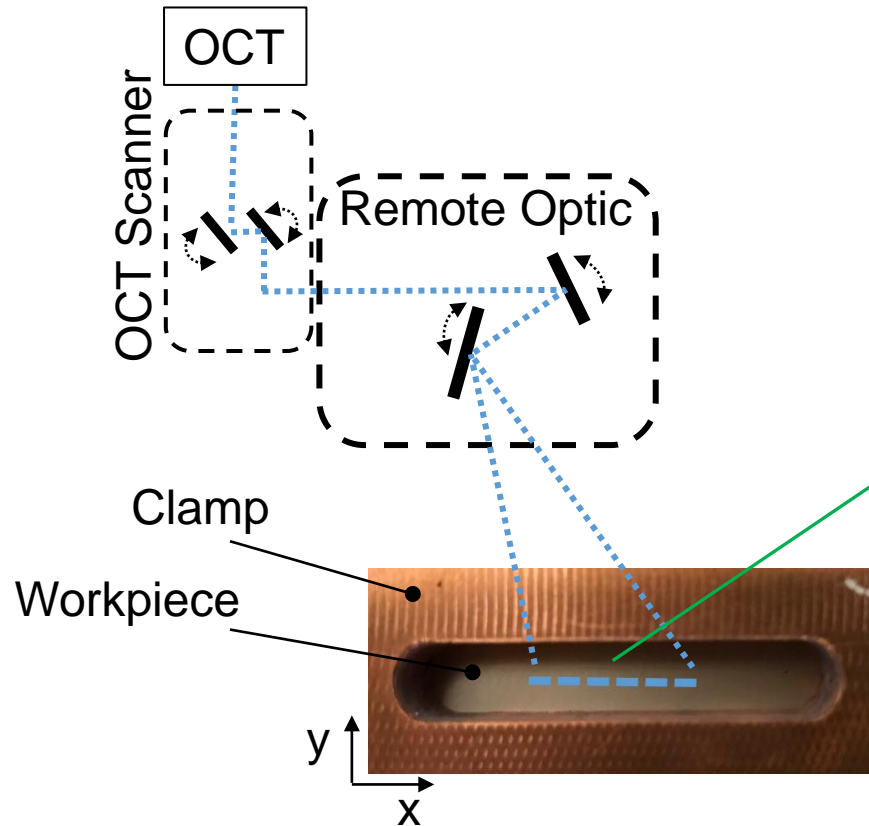
lessmüller
Lasertechnik



- Fast and reliable positioning via OCT.
- Accuracy $< \pm 50 \mu\text{m}$.

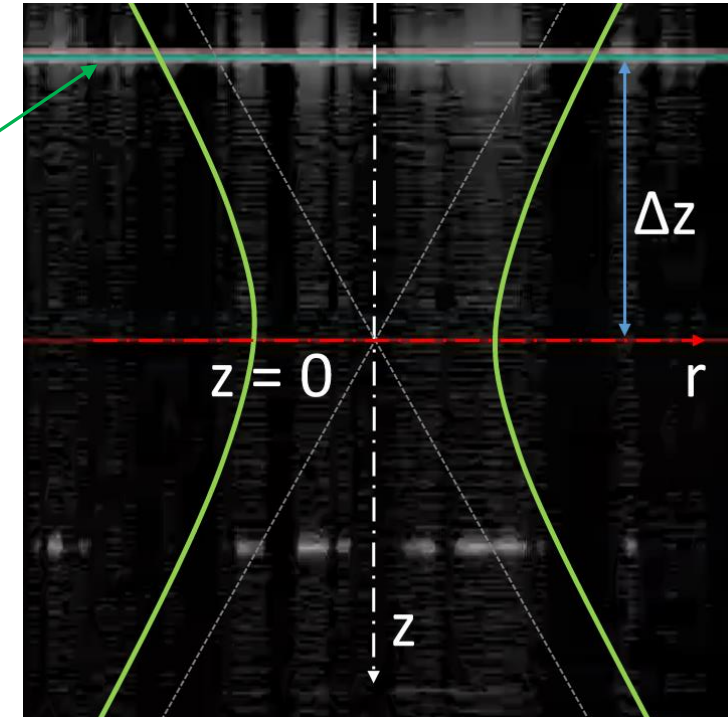
Source: Marius Schwarz, Battery Systems, Bad Nauheim

OCT for focus control



Fast and reliable focus control via OCT.
Accuracy $< \pm 25 \mu\text{m}$

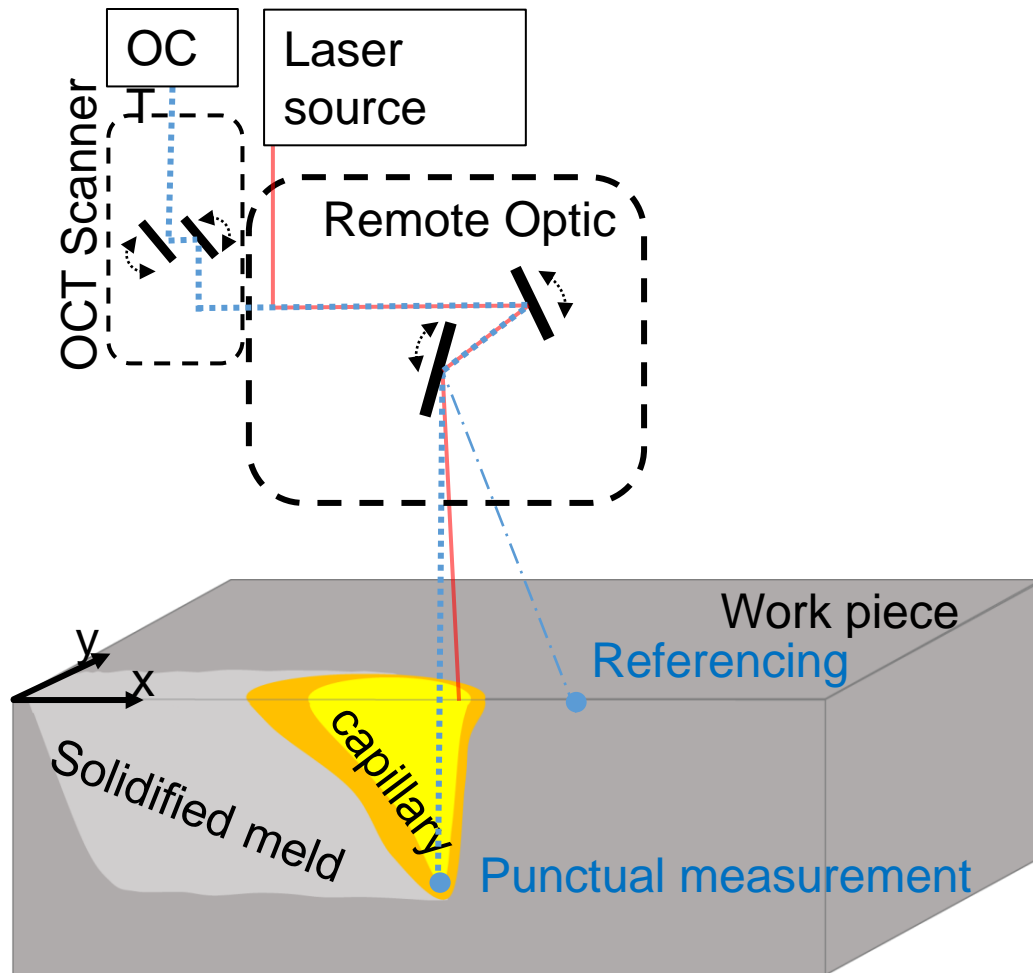
Signal of the work piece



Focus position of
processing laser

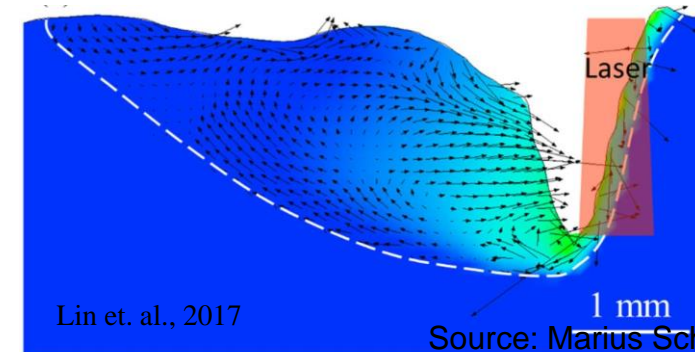
Source: Marius Schwarz, Battery Systems, Bad Nauheim

In-process measurement of capillary depth



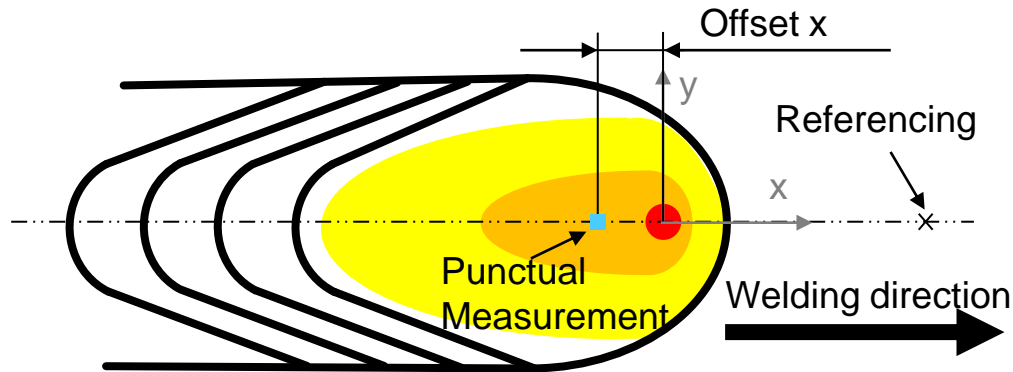
- Scanner-based OCT System enables various measurement modes.
- Especially with very short processing times the inline capillary depth measurement is predestined to monitor the process.
- Line Scan and punctual measurement of the capillary depth can be used for inline-monitoring.

Capillary depth \neq welding depth

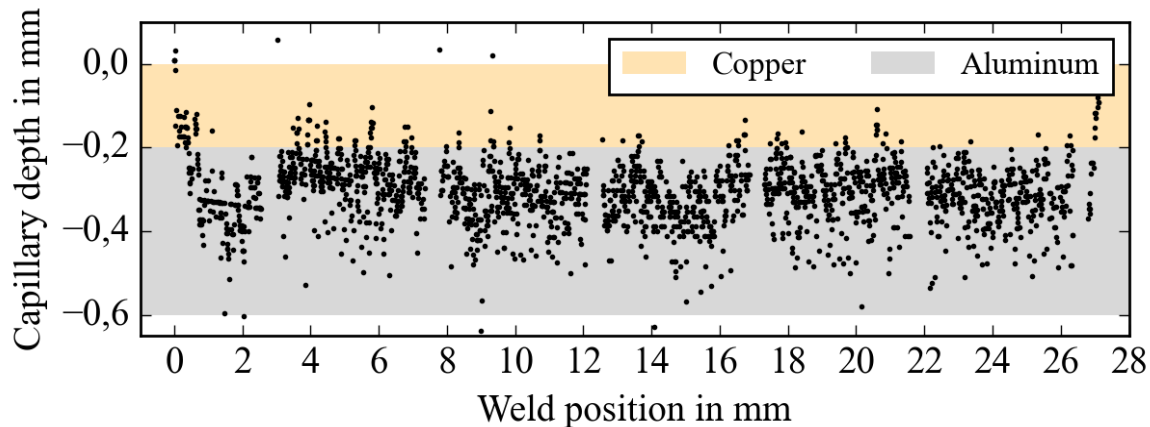


Source: Marius Schwarz, Battery Systems, Bad Nauheim

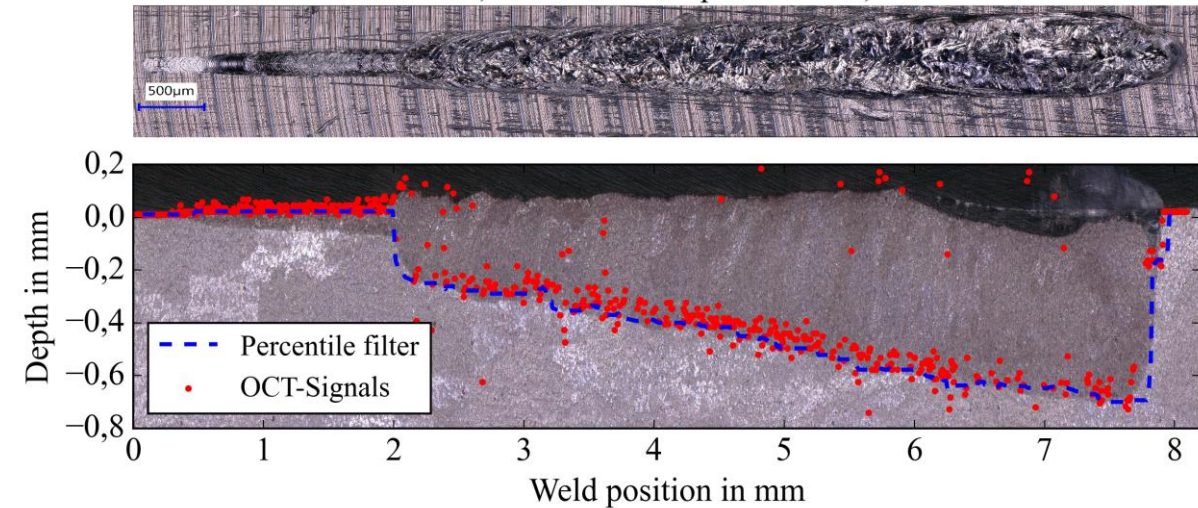
Capillary Depth Measurement - Punctual measurement



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!

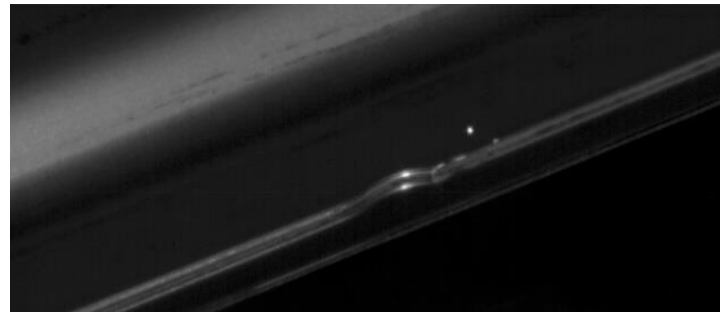
Source: Marius Schwarz, Battery Systems, Bad Nauheim

Applications battery packaging

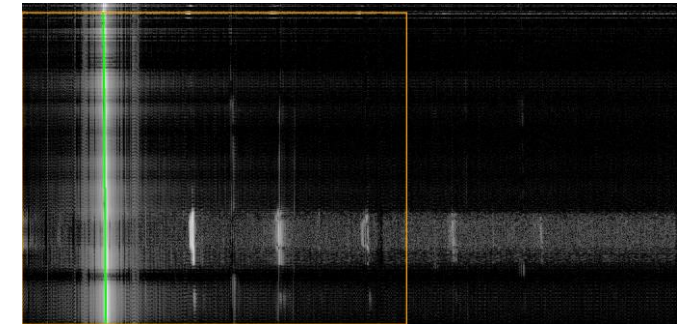
battery packages / systems



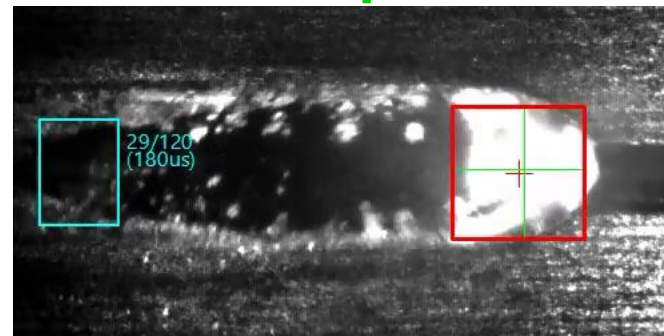
seam tracking- OCT



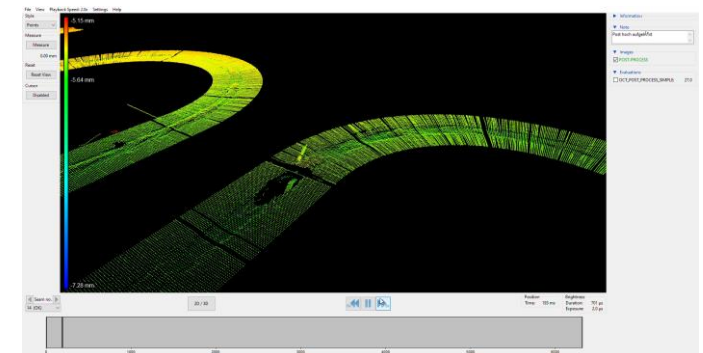
depth measurement - OCT



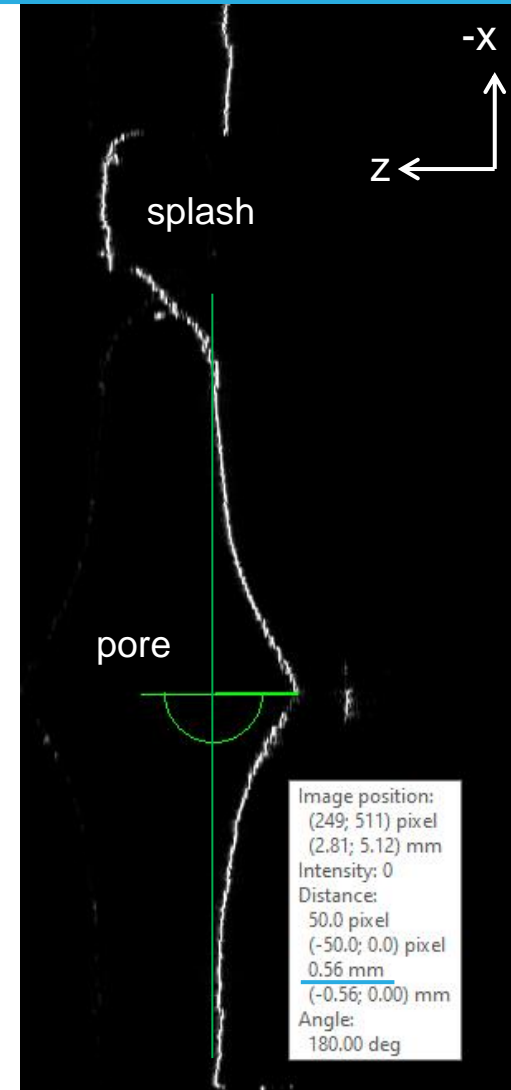
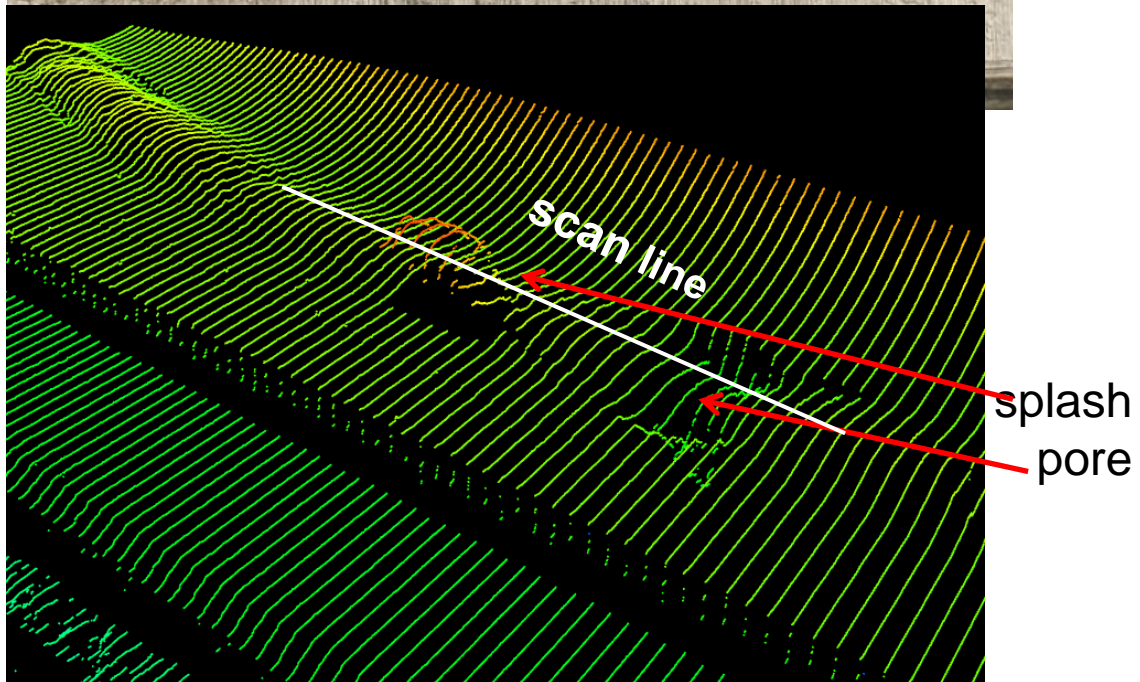
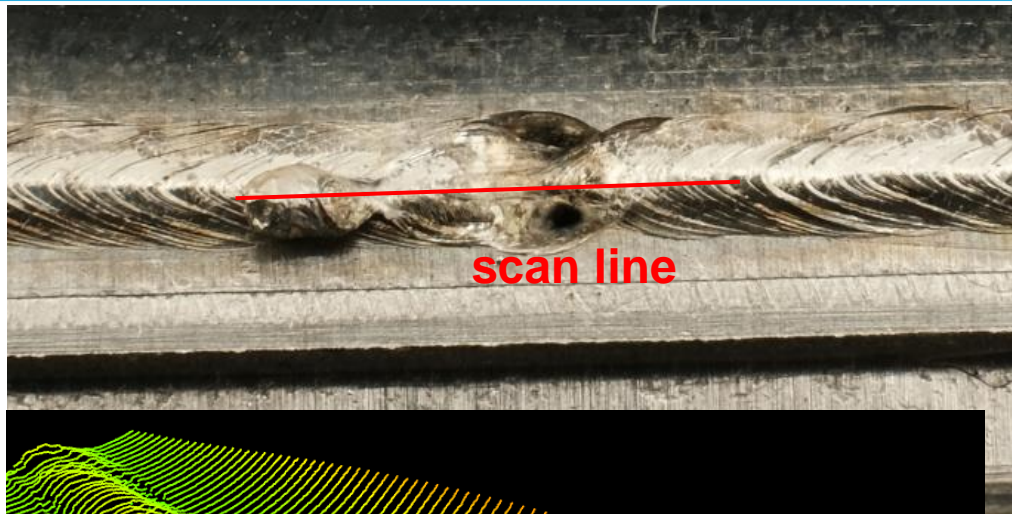
process monitoring – seam inspection



seam inspection - OCT



OCT POST measurement & fault detection



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

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

Optics connected with Lessmüller OCT lessmüller Lasertechnik

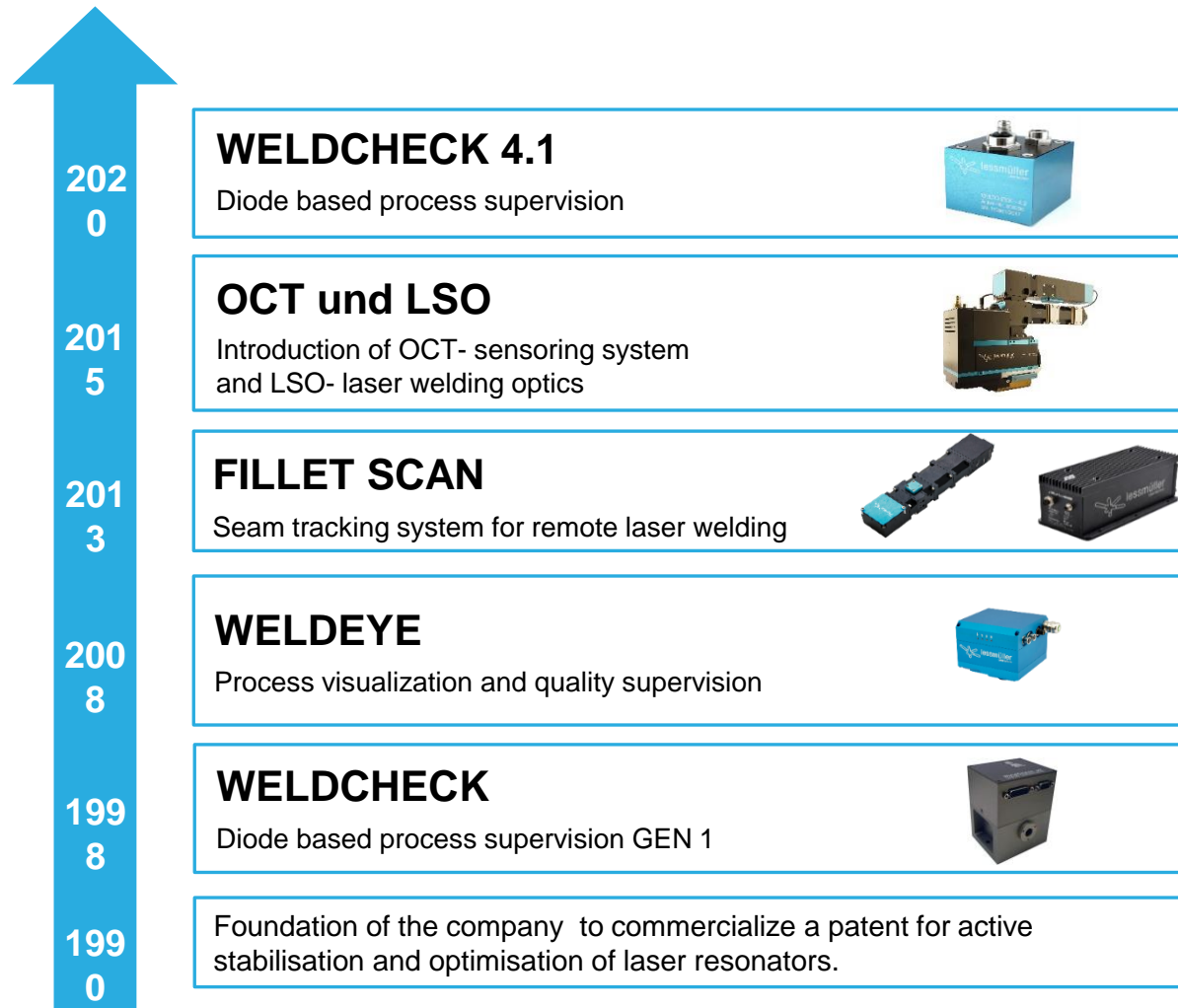
remote optics



fixed optics



History of Lessmüller Lasertechnik



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80339 München

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