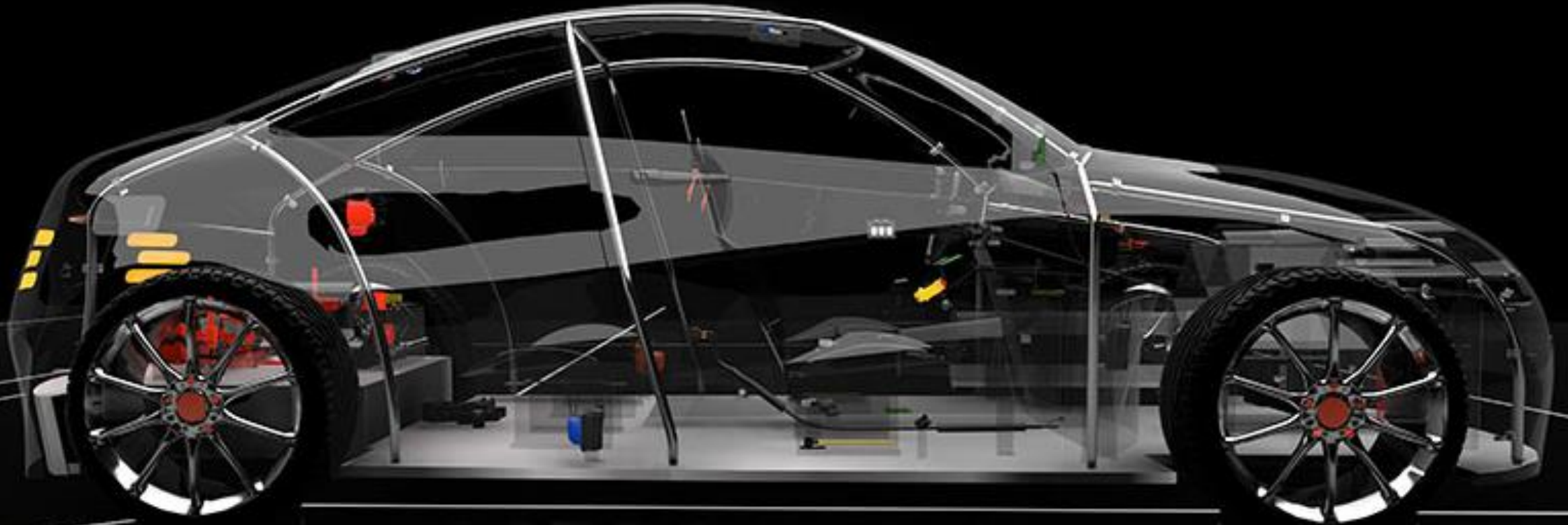


Laser Processes used in the Production of Connector Contacts

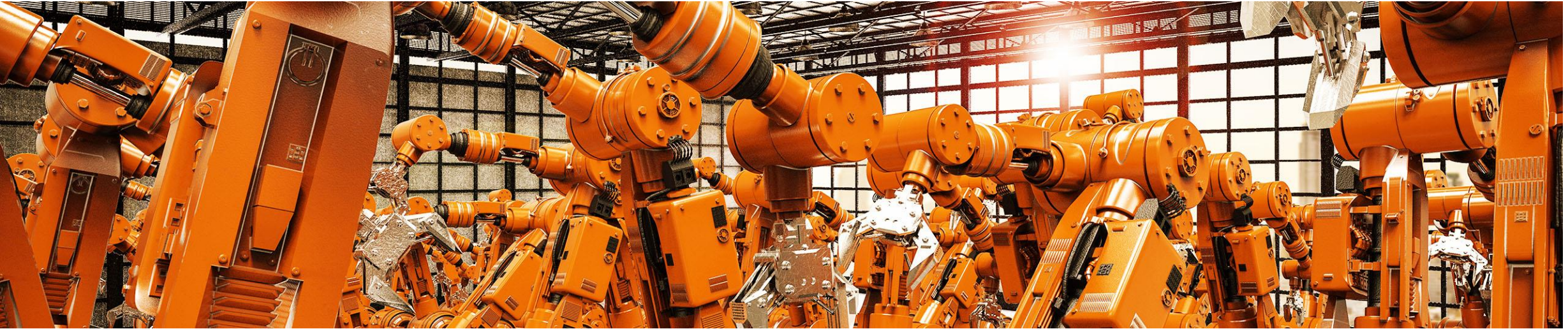
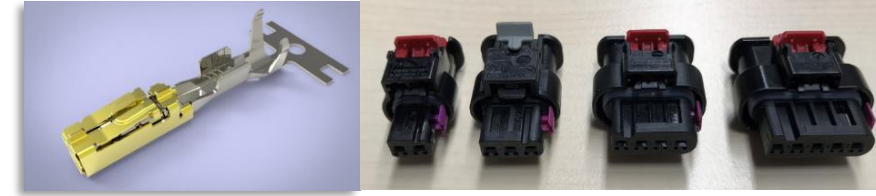


Dr. Isabell Buresch, Daniel Kühn
TE Connectivity GmbH Germany, Wört
isabell.buresch@te.com

Content

- **TE – the world leading connector manufacturer**
- Trends and their consequences for connectors
 - Design
 - Materials
 - Surfaces
- Manufacturing Concepts and Applications
 - Stamping
 - Welding
- Future Strategies and Usage

A World Leader in Connectivity



75+ YEARS LEADING IN CONNECTIVITY

AMP
DEUTSCH
Intercontec

Creganna Medical
Entrelec
Raychem

TRACK RECORD OF RELIABILITY

87%

of FY18 sales in Harsh
Environment Applications

UNMATCHED RANGE OF SENSORS

Fluid Properties
Photo Optic
Position
Temperature

Humidity
Piezo Film
Pressure
Vibration/Force

CONNECTING THE WORLD

220B

PRODUCTS MANUFACTURED ANNUALLY

\$1.8B

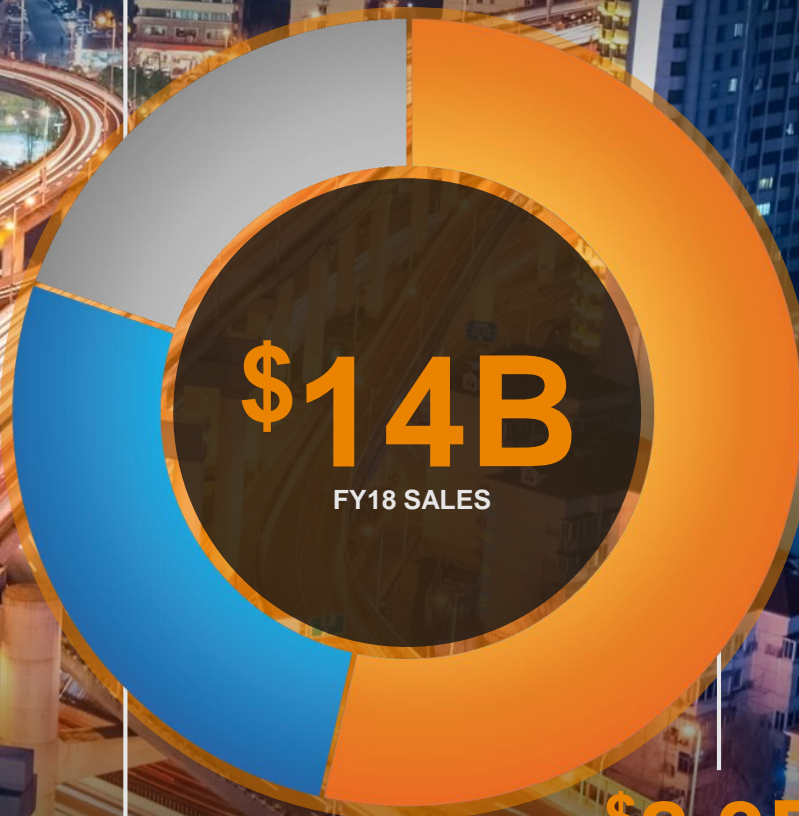
COMMUNICATIONS
Appliances, Data & Devices

\$3.9B

INDUSTRIAL
Industrial, Aerospace,
Defense & Marine,
Medical, Energy

\$8.3B

TRANSPORTATION
Automotive, Industrial & Commercial
Transportation, Sensors,
Application Tooling



FY17 SALES
BY REGION

AMERICAS

\$4.4B

EMEA

\$4.4B

APAC

\$4.3B

GLOBAL PRESENCE

PARTNERING WITH CUSTOMERS IN

150

COUNTRIES

	MANUFACTURING SITES	EMPLOYEES
AMERICAS	40	24,000
EMEA	43	29,000
APAC	21	25,000

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EFFICIENCY / ELECTRIFICATION

Electrification: make things more
save and clean

AUTOMATED & AUTONOMOUS DRIVING

Digitalisation: shift and create profit pools
– shift from hardware to software

CONNECTED CARS

Dematerialisation:
Getting rid of materials
everywhere

AUTOMOTIVE MEGATRENDS CHANGING OUR LIVES

HEMS Challenges



Variety of architectures

12V, 48V, μ HEV, HEV, PHEV, BEV, FC



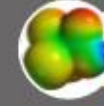
Energy saving and harvesting

technologies become key



Battery is key

for efficiency improvements of powertrain



Lightweight & power density

is in focus



Smaller packaging size and functional integration

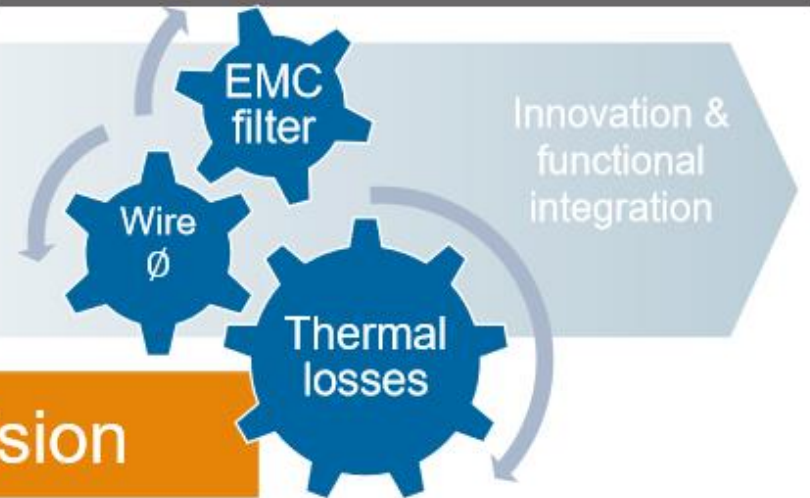
Power train revolution
drives requirements
to its physical
limits

Range
(anxiety)

Battery
size &
performance

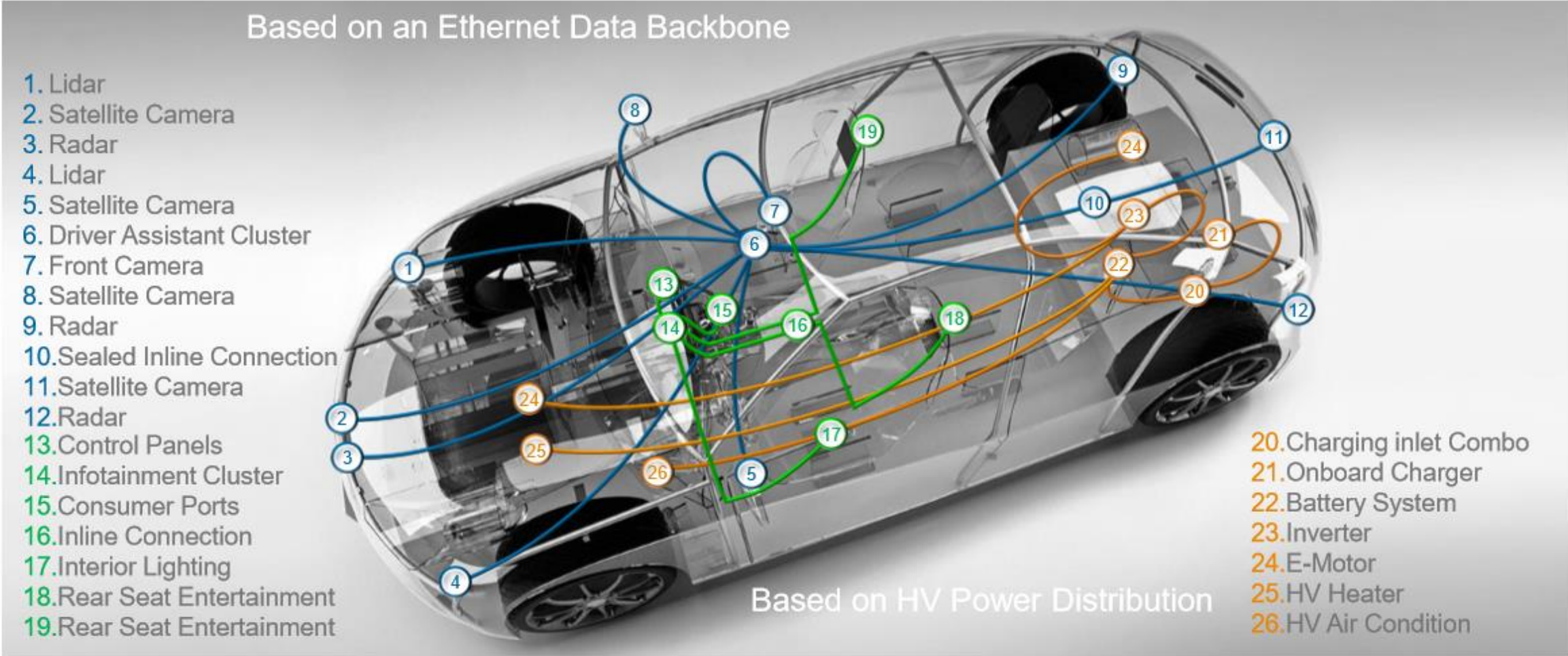
Super fast
charging
400A++

power



Enabling customers to achieve their vision

TE Automotive Data & HV Power Connectivity Solutions



Trends for Connectors

Challenge of power:

Exponential growth of complexity driven by autonomous driving, multiple board net voltages, different driving/powertrain concepts
f. ex. shift from mechanical crankshaft to electrical wire

Changing requirements + increasing requirements:

- Low insertion/mating forces
- Harsh environment
- Miniaturization
- High current up to 600A
- High voltage up to 1000VDC
- High temperature up to 200°C
- Weight reduction
- Cost effectiveness
- High pin count → space
- More intelligence

More smart, more powerful
→ more sensors, less connectors

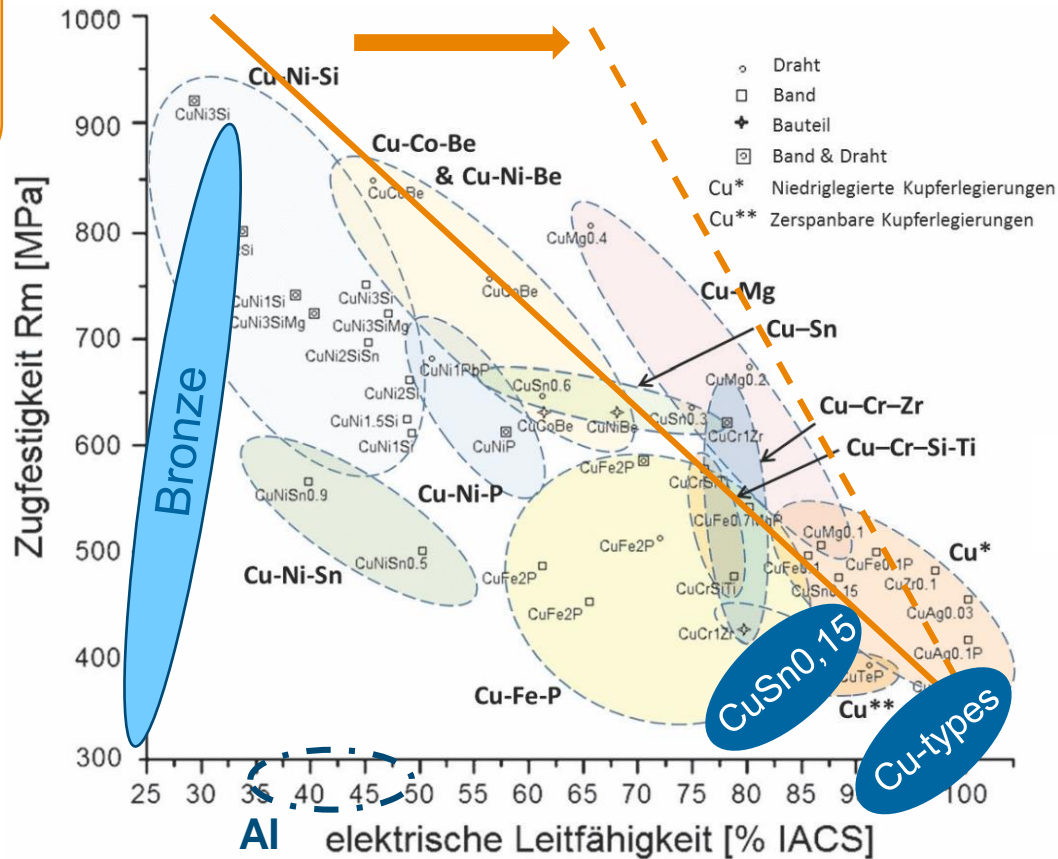
New connectors:
high power, high temp.
HVA 280, HVA 630, HVP 800
PCON 12, PCON21
Next gen. HFP1.2

Core connectivity:
smaller, lighter, more robust,
cost effective



Trends for Materials

- E-Mobility
- Miniaturisation
- Increase / move of limits



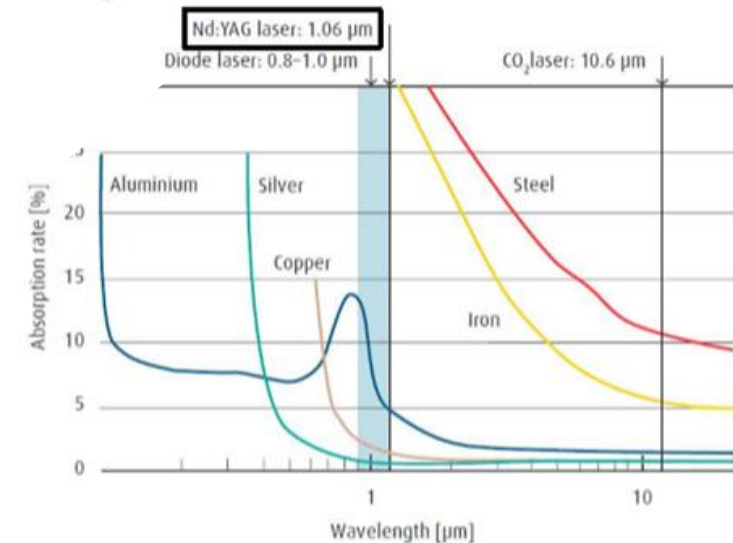
Source: Deutsches Kupferinstitut: Niedriglegierte Kupferwerkstoffe, DKI-i9-2012, Technologieforum Kupfer, Verlag Deutsches Kupferinstitut.

Precipitation hardened alloys

→ welding locally increases hardness

Solid solution hardened alloys

→ welding locally decreases hardness



Connectors – Materialproperties

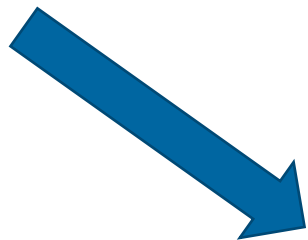
Relevant material properties:

- electr. conductivity
- thermal conductivity
- reflectivity
- surface contamination

conductivity

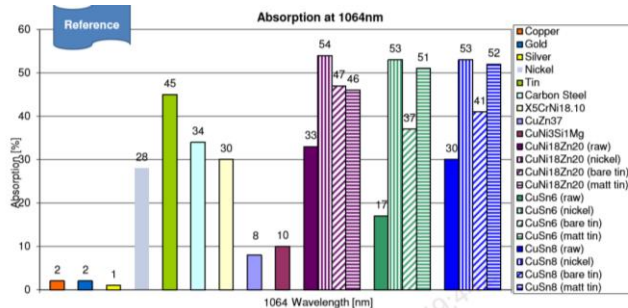


melting point



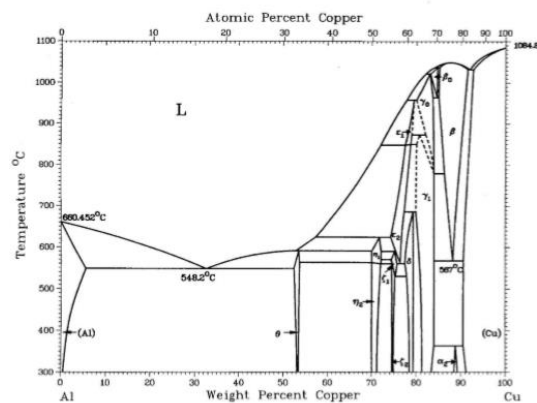
reflectivity

alloying

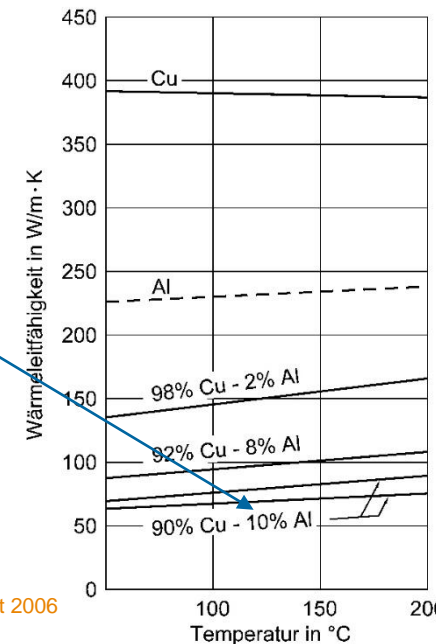


Material	Electr. Conductivity (MS/m)	Thermal conductivity (W/mK)	Melting point (°C)
Ag	61	425	962
Au	45	317	1064
Sn	8	65	232
Al	37	237	660
Cu	59	400	1083
CuSn4-8	12 – 7,5	84 - 62	1070-875
CuNiSi	25 - 29	190 - 250	1100

Wiedemann-Franz-Law



K75 / K88 + Al 99,5 FLS-YAG Laser
Source: BMBF Abschlussbericht Optomat 2006



Content

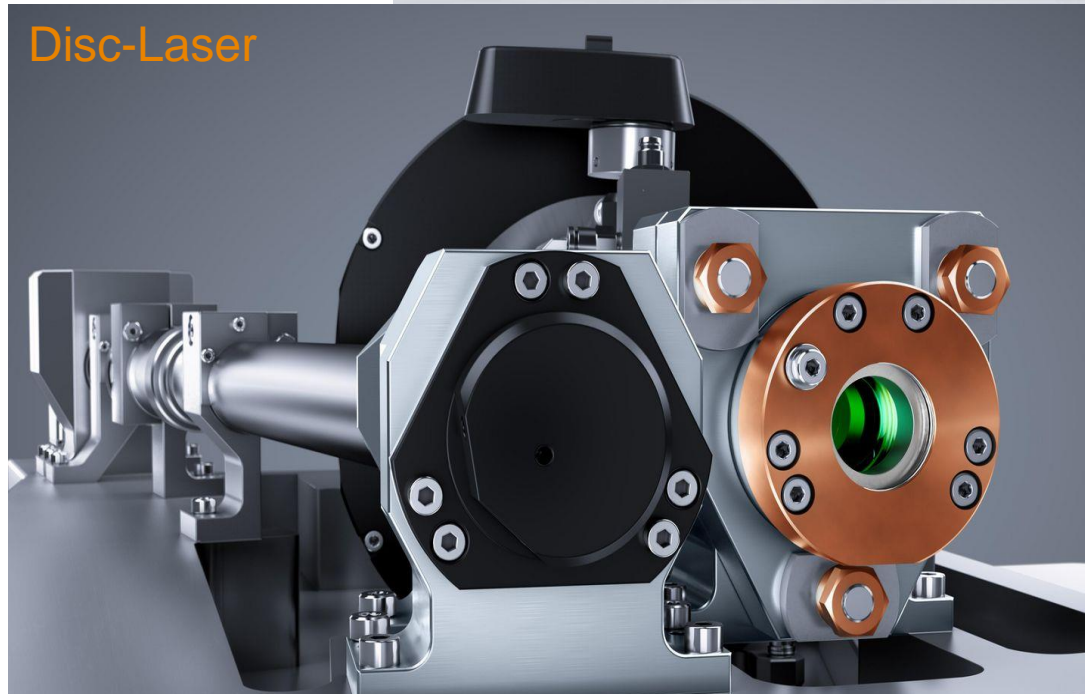
- TE – the world leading connector manufacturer
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 - **Stamping**
 - **Welding**
- Future Strategies

Laser used in the Connector Manufacturing

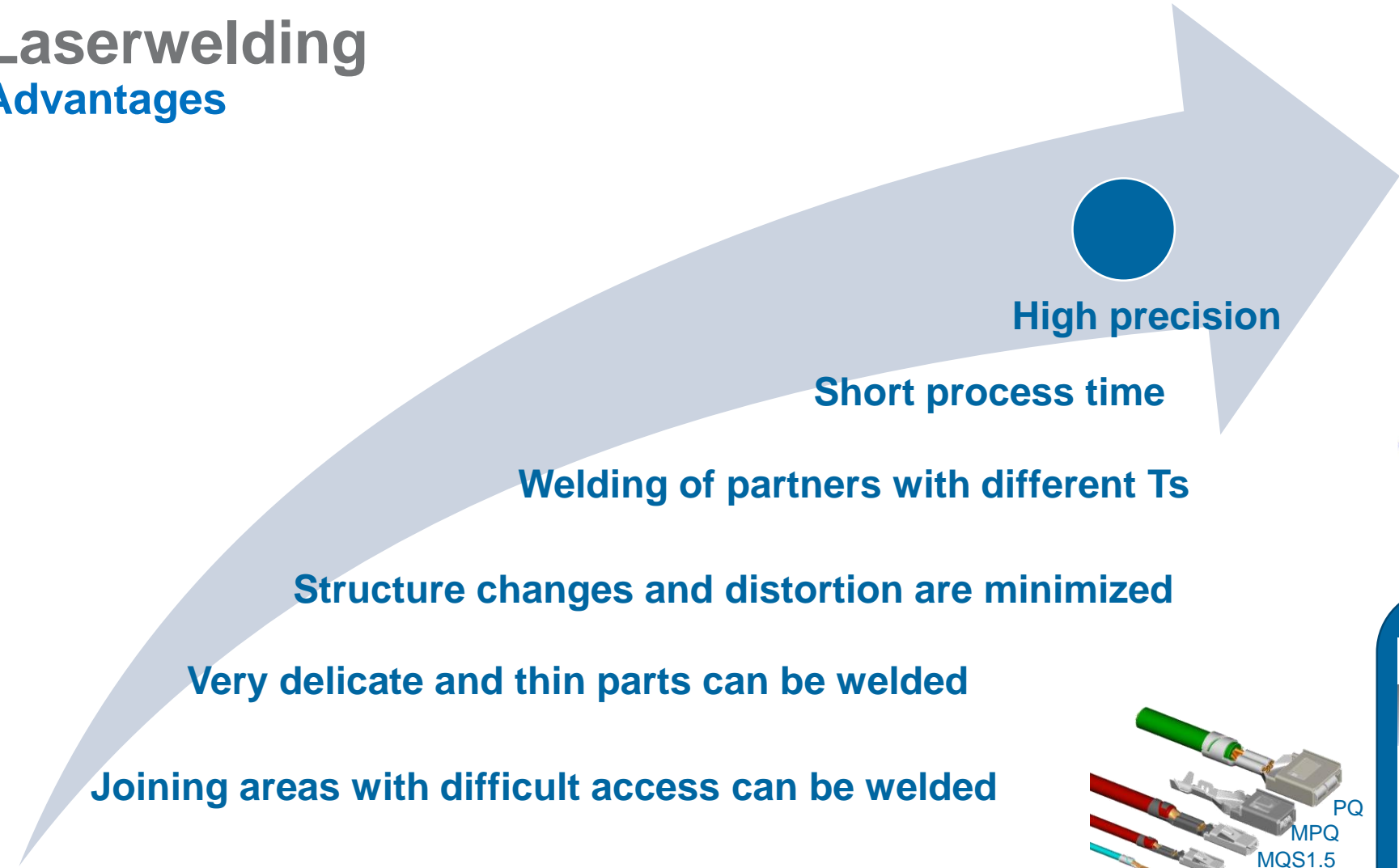
- Disc-Laser (continuous wave (cw))
- Diode Laser
- Fiber Laser
- Short-/Ultrashort Puls Laser
- Pulsed Laser
- Marking Laser (green, infrared, UV)



- Welding (point, seams, Additive Manufacturing)
- Temper/Heating
- Bending / Forming
- Build-up welding
- Marking
- Drilling
- Ablation
- Hybridwelding
- Hardening
- Soldering
- Micromachining
- Structuring
- Diffusion
- Cleaning
- Melting



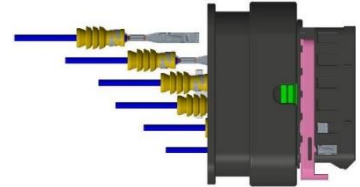
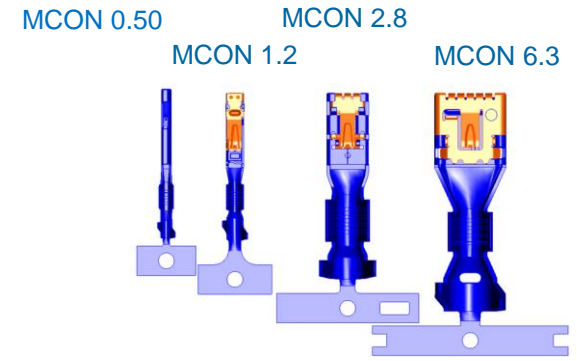
Laserwelding Advantages



Targeted and locally limited heat input



Miniaturisation



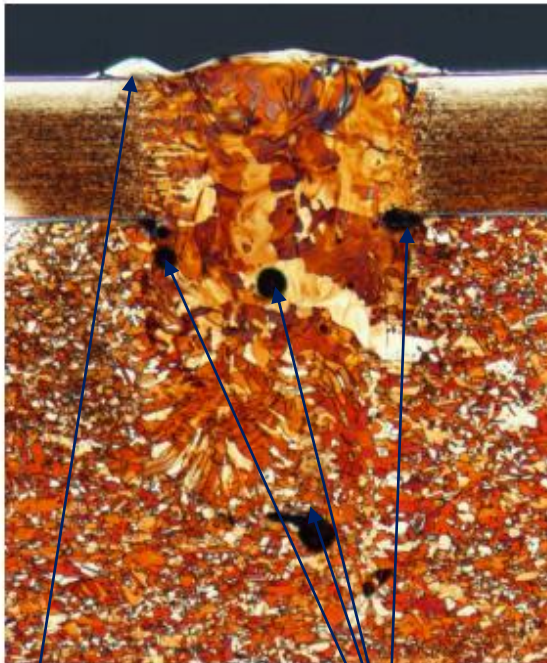
8 x 12 = 96

10 x 17 = 170



Typical welding problems

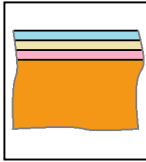
oxidized base material



coating dewettings

pore formation

Ag pass.
Sn
Ni



961°C
232 °C
1455°C
1100°C

Cu Alloy

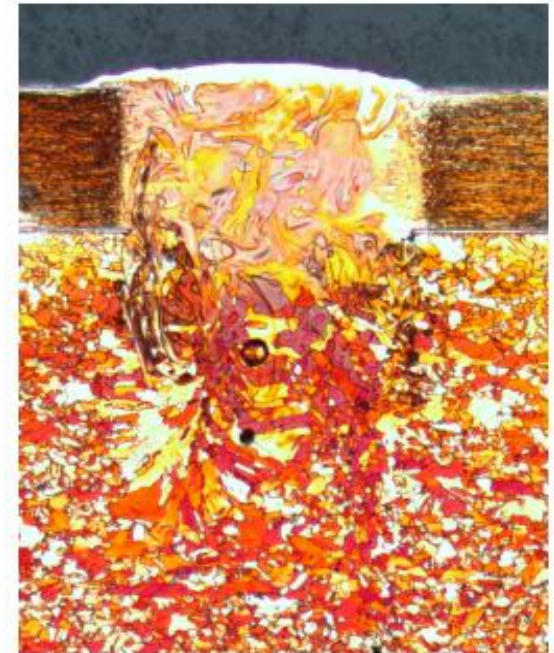
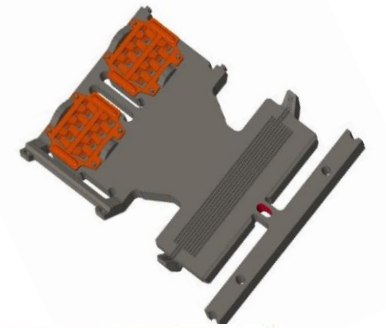
Ag pass.
Sn
Ni

Cu Alloy



Coating blistering

Laserwelding – seam weld:
Single mode Fiber Laser (cw)



Thank You

Dr. Isabell Buresch, Daniel Kühn
TE Connectivity GmbH Germany, Wört
isabell.buresch@te.com
daniel.kuehn@te.com

Acknowledgement

- Uwe Hauck
- Willi Dietrich
- Martin Henle