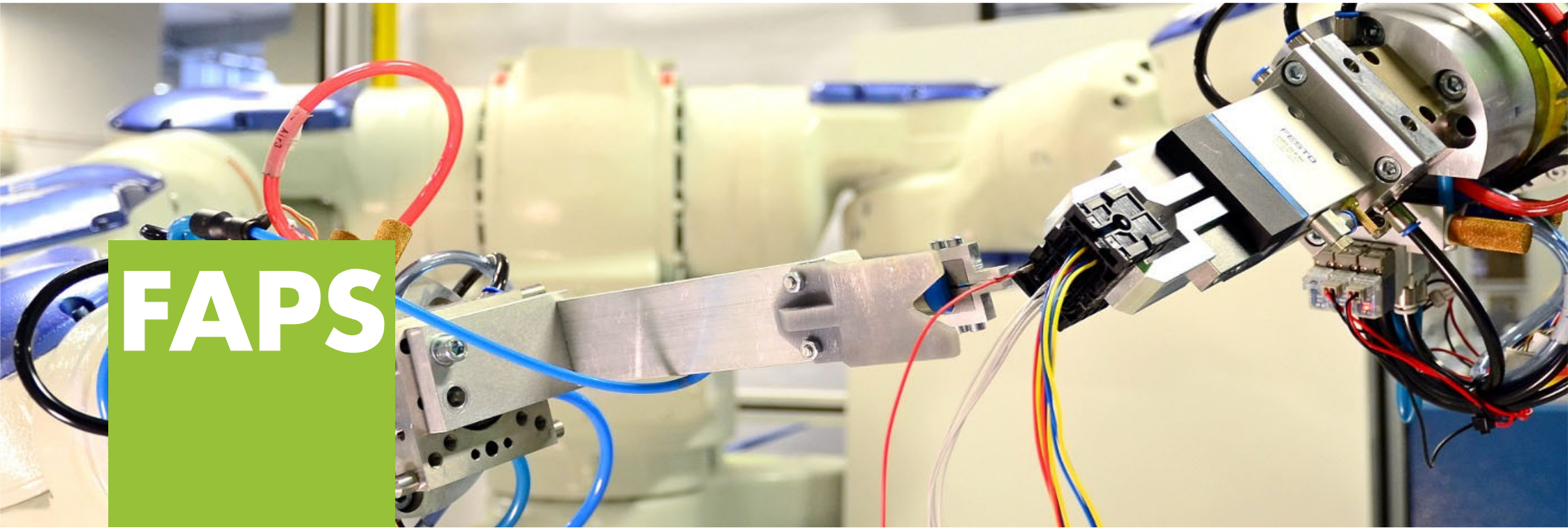


Prof. Dr.-Ing. Jörg Franke

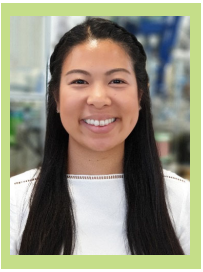
Lehrstuhl für Fertigungsautomatisierung und Produktionssystematik

Friedrich-Alexander-Universität Erlangen-Nürnberg

Friedrich-Alexander-Universität
Technische Fakultät

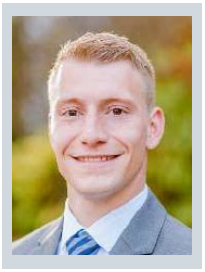
Forschungsbereich Signal- und Leistungsvernetzung

Im engagierten, kreativen Team des Forschungsbereiches Signal- und Leistungsvernetzung sind interdisziplinäre Kompetenzen vorhanden.



Huong Nguyen,
M.Sc., FB-Leitung

Automatisierung und optische Inspektion im Bordnetzbereich

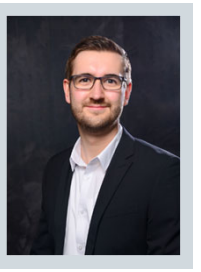


Simon Fröhlig, M.Sc.

Automatisierte Verdrahtung im Starkstrombereich

Jan Fröhlich, M.Sc.

Anwendungen und Zuverlässigkeit gedruckter Elektronik



Patrick Bründl, M.Sc.

Effizienzsteigerung und Digitalisierung im Schaltschrankbau

Micha Herbert,
M.Eng.

Effizienzsteigerung und Digitalisierung im Schaltschrankbau

Niklas Piechulek,
M.Eng.

Selektiv metallisierte Bauteile in der Luftfahrt

Robert Süß-Wolf
Dipl.-Ing.

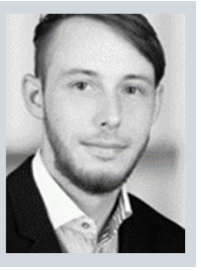
N-Kubator und Ausgründung

Lorenz Schmidt
Dipl.-Ing.

Digital Twin im Leitungssatzdesign

Lisbeth Silva,
Dipl.-Ing. (FH)

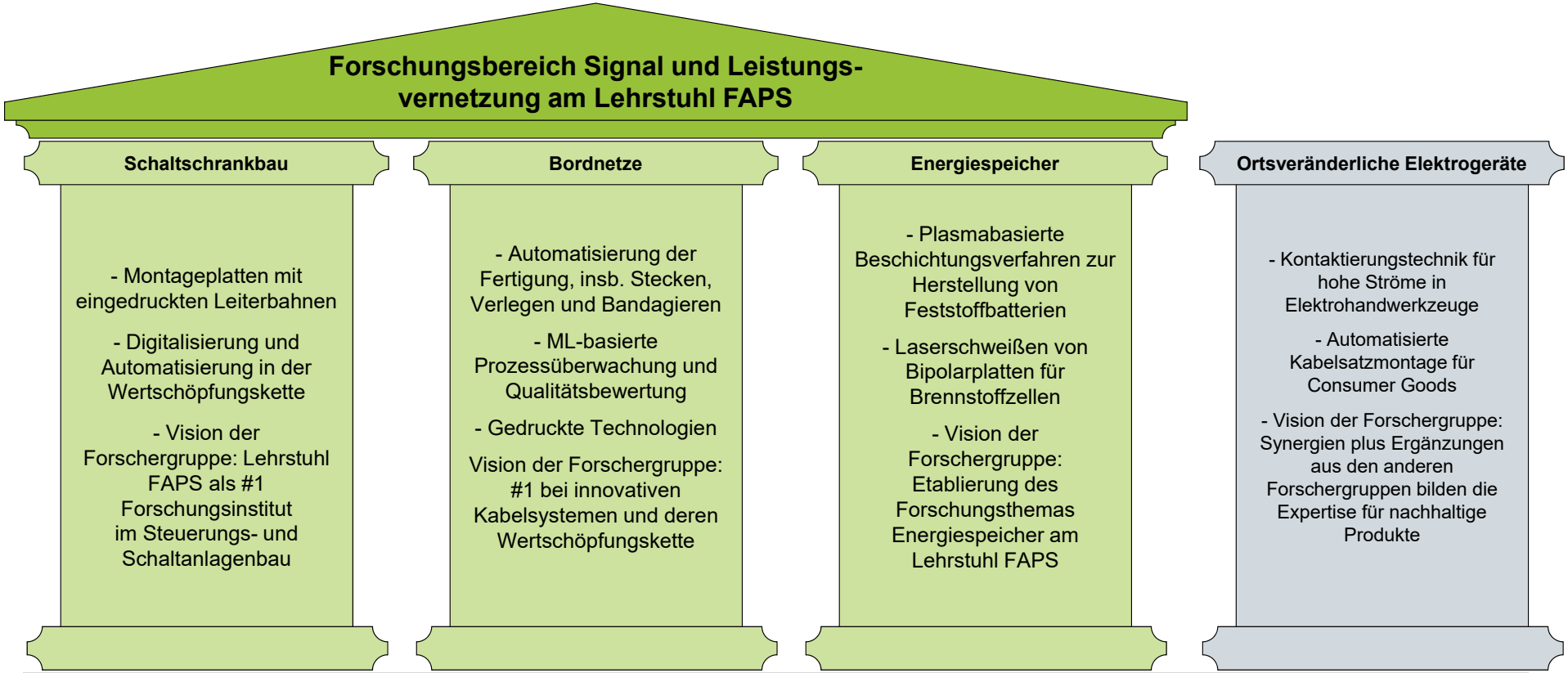
Labor und Analytik



Jean Phillip Buttler,
Industriemeister

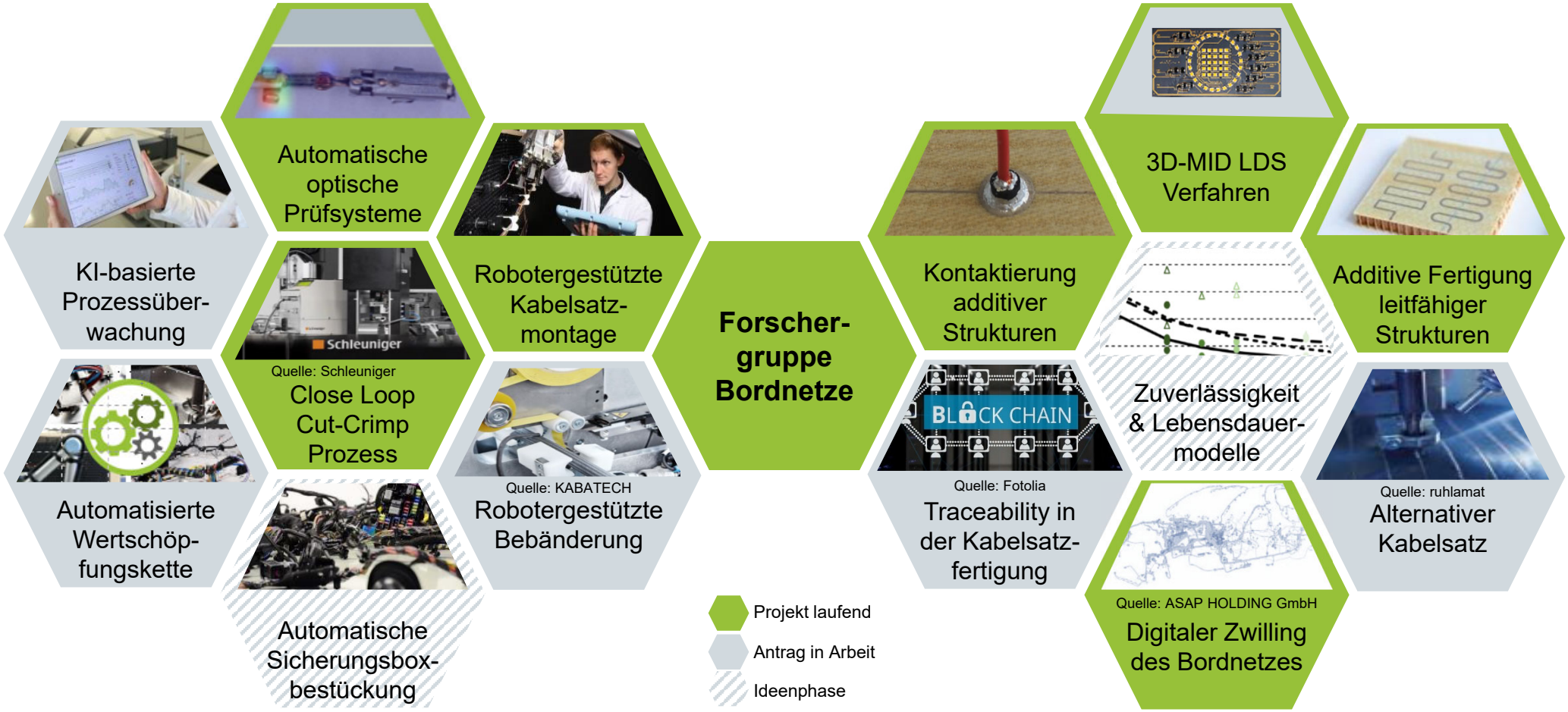
Technik und Mechanik

Die Organisation des Forschungsbereichs „Signal- und Leistungsvernetzung“ würdigt die wachsende Vielfalt der Forschungsinhalte und die beteiligten Branchen.



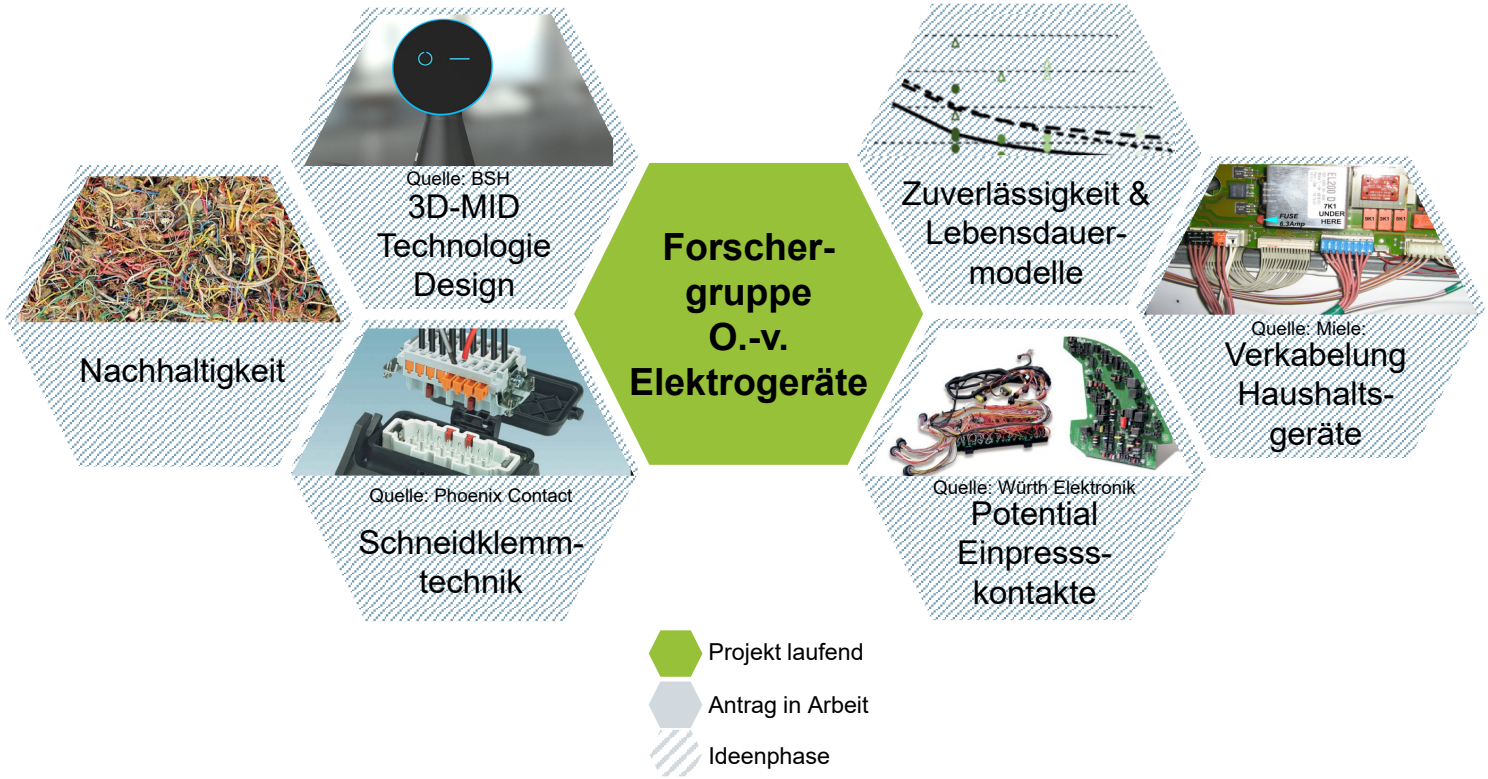
In der Forschergruppe Schaltschrankbau arbeiten 4 wissenschaftliche Mitarbeiter an innovativen Lösungen für die Signal- und Leistungsvernetzung.

Die Forschergruppe Bordnetze bearbeitet Projekte entlang der Wertschöpfungskette für Kabelsysteme.



Durch die Akquise von Projekten im Bereich der Batterie- und Wasserstofftechnologie etabliert die Forschergruppe „Energiespeicher“ dieses spannende Themenfeld am Lehrstuhl FAPS.

Aus der Expertise von Industrieprojekten und Anfragen aus dem Netzwerk soll die Forschergruppe „Ortsveränderliche Elektrogeräte“ dieses Thema im FB LSV etablieren.



Development of a robotic system with machine learning-based process monitoring and quality control for the automated final assembly of wiring harnesses.

Motivation: Manual manufacturing of wiring harnesses

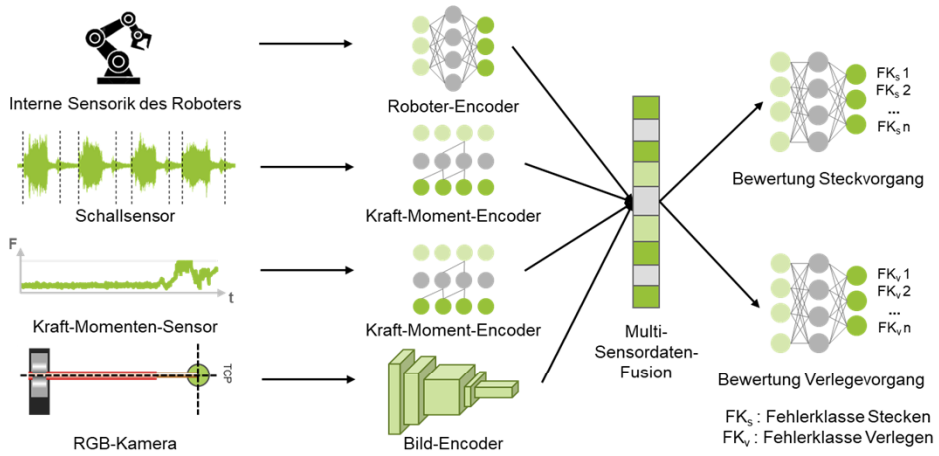
- Up to 90% manual work in the final assembly of wiring harnesses
- Failures are detected at end-of-line testing which results in high costs and effort for trouble shooting or even scrap

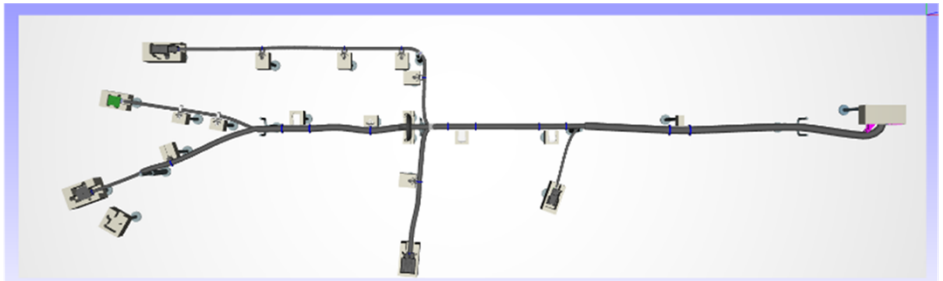
Objective: Automation in the wire harness manufacturing

- Increase degree of automation for the process steps wire grasping, inserting, and routing
- Establish reproducible and transparent assembly processes with documented quality parameters

Solution: Robotic assembly and multisensor data fusion

- Development of a robotic solution and gripper for the automated handling of deformable linear objects
- Sensor data collection and machine learning-based processing for in-line quality monitoring and process steering
- Continuous data flow from engineering for path planning





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Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages

Development of a deep learning enabled automated optical inspection system for the on-the-fly quality assessment of crimp connections.

Motivation: Quality control and holistic documentation

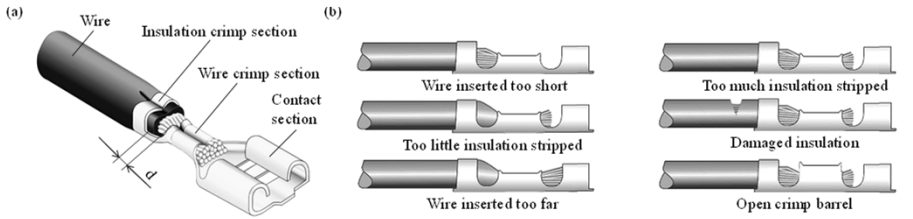
- Manual optical inspection of crimp connections after tool and material change or randomly during production
- State-of-the-art quality assessment and monitoring on an component level is based on force curves

Objective: Increase automation of optical inspection

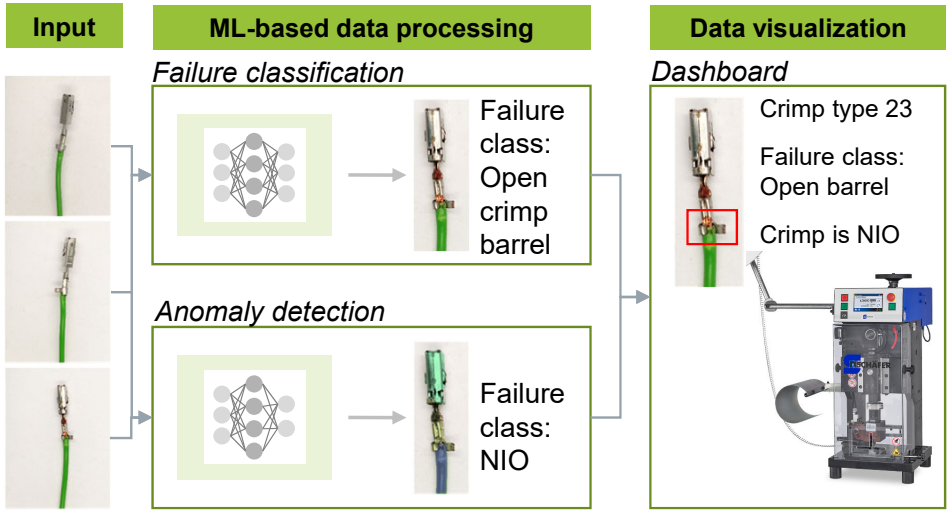
- Development of an automated optical inspection systems for in-line quality monitoring in crimping machines
- Realize hardware and algorithms for on-the-fly image capturing, real-time analysis, and visualization

Solution: Machine learning for image data processing

- Machine learning-based anomaly detection and failure classification for cut and crimped wires
- Prediction of crimp quality and visualization of failures on machine for trouble shooting
- Increase the transparency of machine learning algorithms



(a) i.O. Crimp (b) n.i.O failure classes; Source: Kabelforum, DIN EN ISO 60352-2:2005



OptiCrimp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The conceptual design of digital services and lean manufacturing processes resulting from DigiSchalt offer great potential for optimizing the panel building industry.

Motivation: Manual processes and digital discontinuities

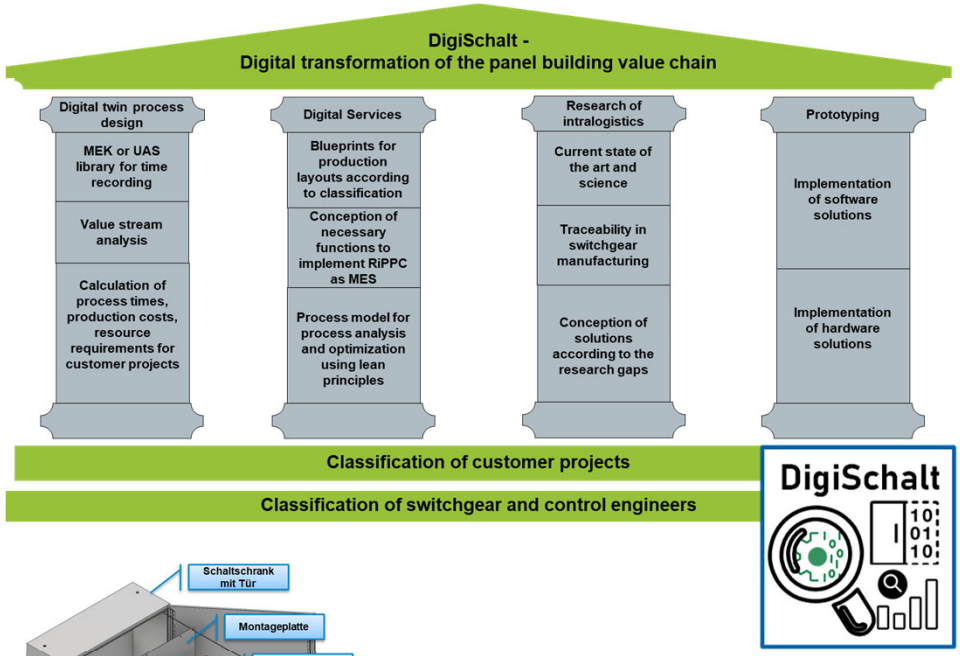
- Switchgear manufacturers often lack capacity for process optimization since employees are tied up in daily business
- Manufacturing with many variants up to batch size 1 prevents economies of scale and the use and implementation of automation solutions

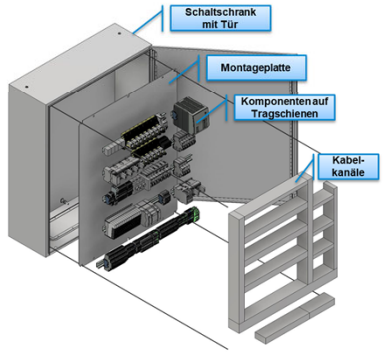
Objective: Optimizing efficiency of panel building processes

- Calculation of process times, production costs, resource requirements for customer projects
- Blueprints for production layouts according to classification
- Traceability in switchgear manufacturing

Solution: Implementing digital data and processes

- Classification of panel builders and projects
- Digital twin of a switchgear manufacturing factory
- Procedure model for the optimization of production processes according to Lean principles





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Wiring and mechanical assembly, which account for almost 72% of the working time in the manufacture and assembly of control cabinets, offer great potential for optimization.

Motivation: Manual manufacturing of control cabinets

- Increase in the number, variety, and complexity of components installed in the control cabinet
- Labor-intensive, predominantly manual workshop production
- Data discontinuities, insufficient use of IT systems, and lack of economies of scale make economical production difficult

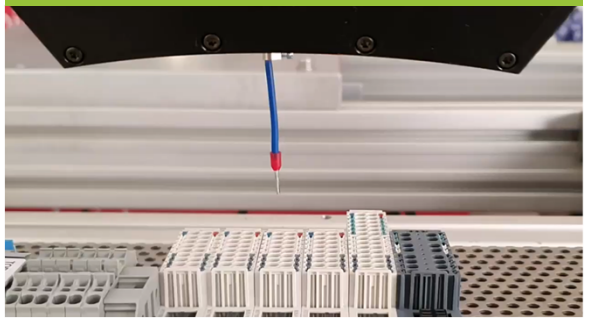
Objective: Increase efficiency in the manufacturing process

- Development of economical production solutions, especially for small and medium-sized enterprises
- Possibility of late individualization while guaranteeing faultlessness of the products
- Decrease of delivery time

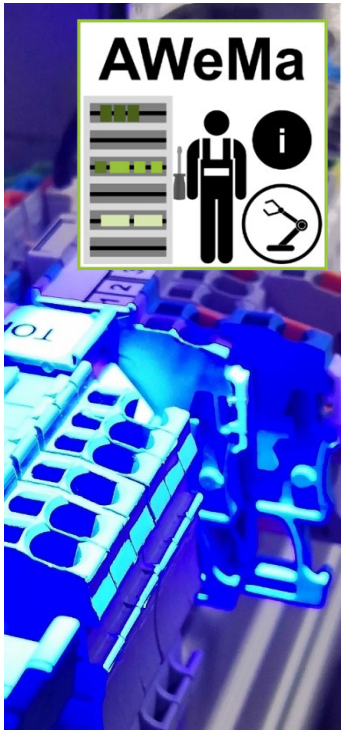
Solution: Automation and digital worker assistance

- Development of an assistance robot system for the automated insertion of prefabricated cables
- Conceptual design of a digital worker assistance system for the manual work steps of mechanical assembly and wiring

Automated insertion



Digital worker assistance



Further information:
Florian Hefner, Simon Schmidbauer, Jörg Franke, **Pose error correction of a robot end-effector using a 3D visual sensor for control cabinet wiring**, Procedia CIRP, Volume 93, 2020, Pages 1133-1138, ISSN 2212-8271, https://doi.org/10.1016/j.procir.2020.04.088.
Florian Hefner, Simon Schmidbauer, Jörg Franke, **Vision-based adjusting of a digital model to real-world conditions for wire insertion tasks**, Procedia CIRP, Volume 97, 2021, Pages 342-347, ISSN 2212-8271, https://doi.org/10.1016/j.procir.2020.05.248.

The "SUPPLy" research project is concerned with the automated manufacturing of charging stations for electromobility and the challenge of handling deformable objects.

Motivation: Manual manufacturing of charging stations

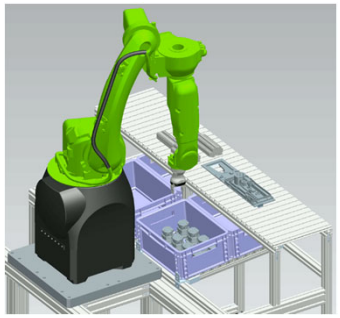
- Increase in electrified vehicles requires provision of the necessary charging infrastructure
- Primarily manual manufacturing and assembly processes of charging structure equipment

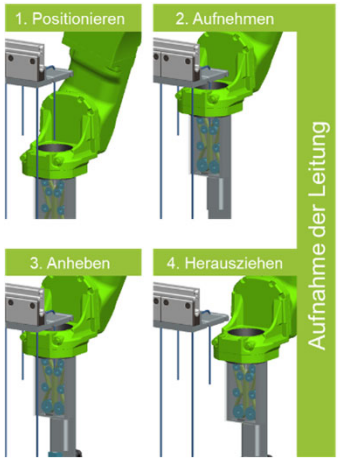
Objective: Increase automation and scalability of production

- Development of an outlet module tailored to assembly and automation requirements
- Proof of concept for main production processes (e.g. wiring)
- Scalable assembly concepts for flexible output adaption

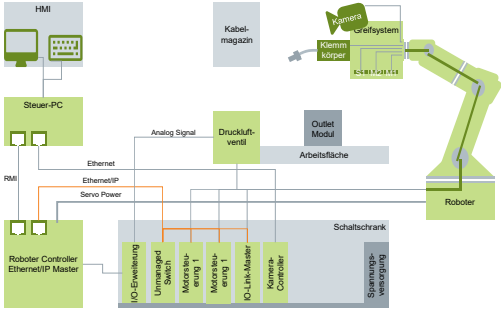
Solution: Redesign for automation and automated wiring

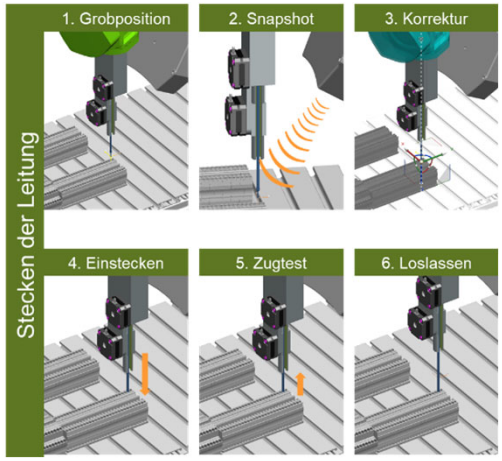
- Application and further development of the methods Design for Automation & Assembly
- Use of hybrid assembly systems in u-shape arrangement
- Simulation of linear deformable objects as handling object





SUPPLy





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Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages

The "EFFEKT" research project is concerned with the manufacturing of laser direct structured (LDS) mechatronic devices for aviation and the challenge of additive manufacturing.

Motivation: Designing eco-efficient cabin interior

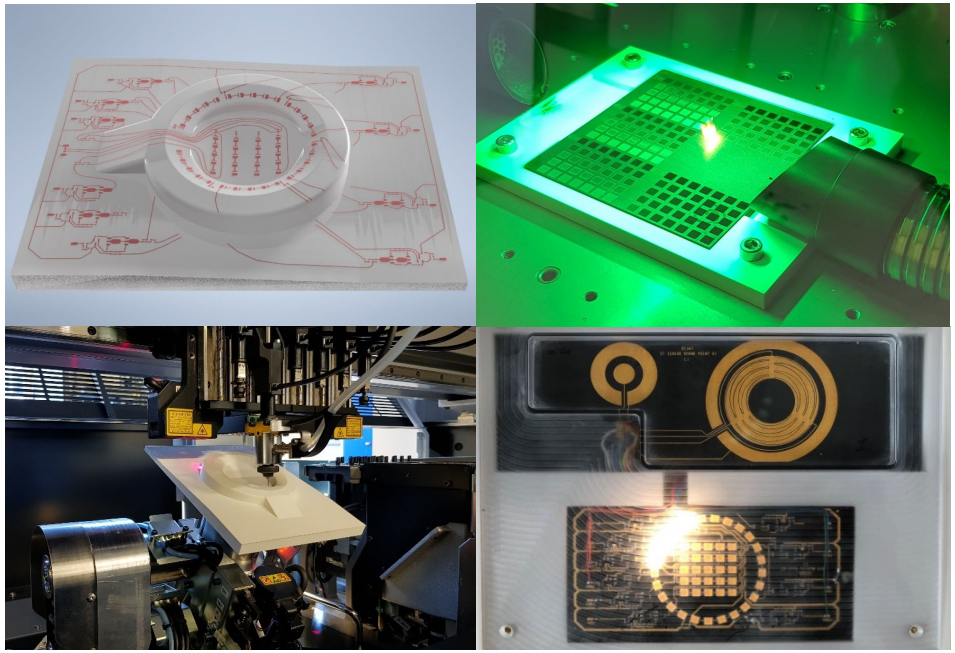
- Substitution of printed circuit boards and cables to reduce development costs, material consumption and assembly effort.
- Reduction of the weight and space requirements, in order to reduce the resources needed in operation.

Objective: Reduction of manufacturing complexity

- Cost-effective production of small quantities and customized products
- Reduction of material usage in the assemblies
- Increasing the integration density

Solution: Passenger Service Unit in LDS-MID technology

- Development of aerospace grade materials suitable for the LDS process
- Lighting and capacitive sensor technology on the surface of cabin parts



DIEHL Aerospace

EFFEKT

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Within the project “PrInterfaces”, the failure mechanisms of various contacting options for printed electronics at the system level are systematically investigated.

Motivation: Challenges in contacting for printed electronics

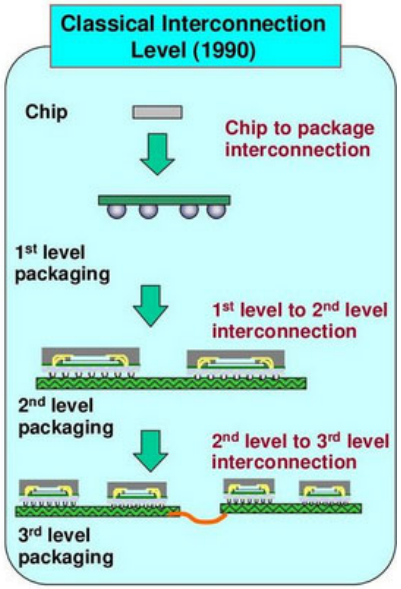
- Rising number of applications for printed electronics requires reliable contacting
- The flexibility in geometry and material choices comes with several challenges regarding contacting

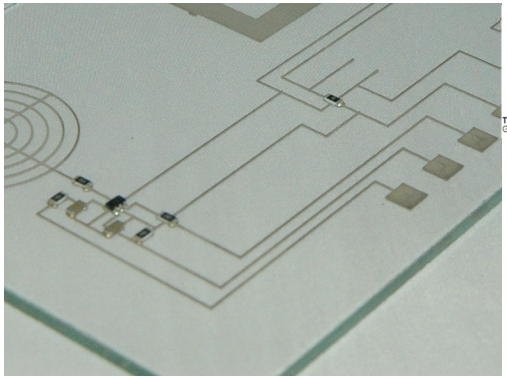
Objective: Find reliable contacting methods

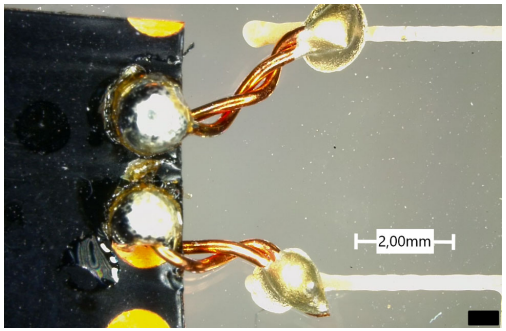
- Identify failure mechanisms of different connections
- Asses the long term reliability, according to relevant norms
- Develop a user guide for contacting printed electronics

Solution: Systematic investigation of contacting systems

- Development of contacting systems for relevant use-cases
- Conducting root cause analyses
- Development of mechanical, electrical and material models







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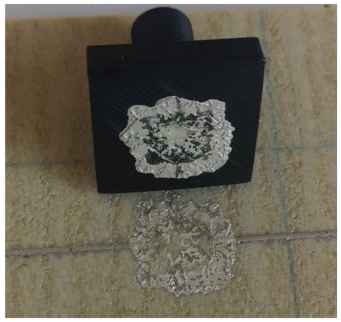
Aim of the project “AngElo” is the development of a reliable and automatable connection of printed electronics to the electrical system of the aircraft.

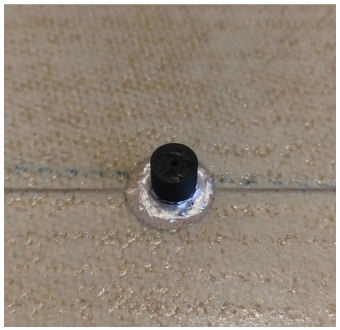
Motivation: Reducing cables within the aircraft

- In contrast to usual wiring, printed electronics save space and weight, and can be applied automatically
- To establish printed electronics within the aircraft reliable and automatable connections are needed



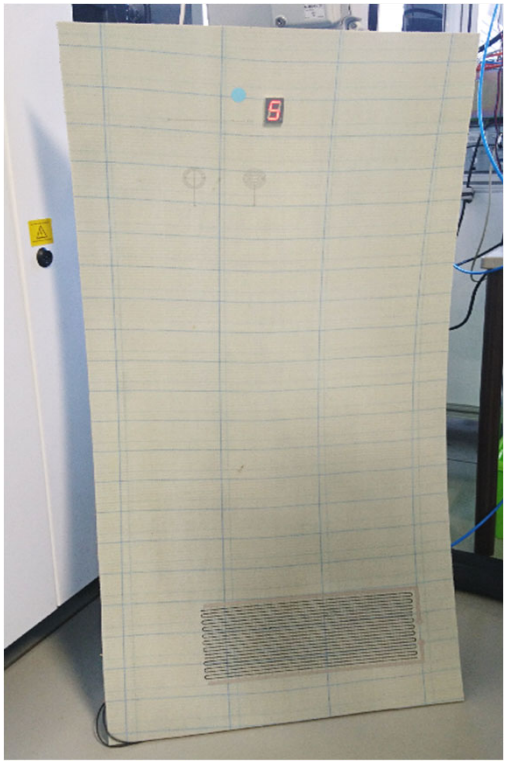
Objective: Find a reliable and automatable connector

- A reliability that is comparable to conventional connectors has to be verified
- A method for the automatic integration of the connector into the printed system has to be established



Solution: Development and verification of models

- Analysis of conventional connectors in the aviation
- Development of different demonstrators
- Verification according to aviation norms



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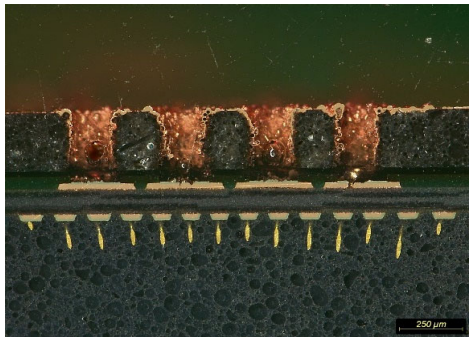
In the FAPS laboratories, a wide range of properties of prototype sample components can be characterized, analyzed and documented.

Motivation: Details matter in various fields of application

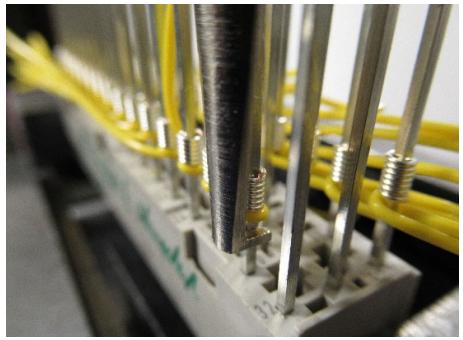
- to understand mechanisms
- to analyzes problems
- to qualify products

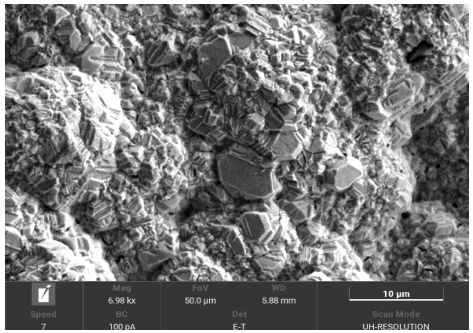
Objective: Diverse measuring methods for detail analyzation

- Metallography for structural analysis (micrographs)
- Light microscope / Digital microscope for visualization and measurement of samples
- X-ray fluorescence analysis for coating thickness measurement
- Temperature and climate testing
- Chemical resistance
- Tensile strength and elongation testing up to 10kN
- Viscosity determination
- Roughness analysis using 3D laser scanning microscope
- SEM with EDX

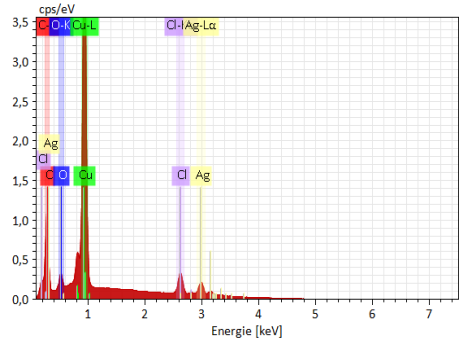


Micrograph of a connected Chip with the LDS method


Tensile strength test of a “Wire-Wrap” connection



SEM image of an LDS copper line



EDX analysis

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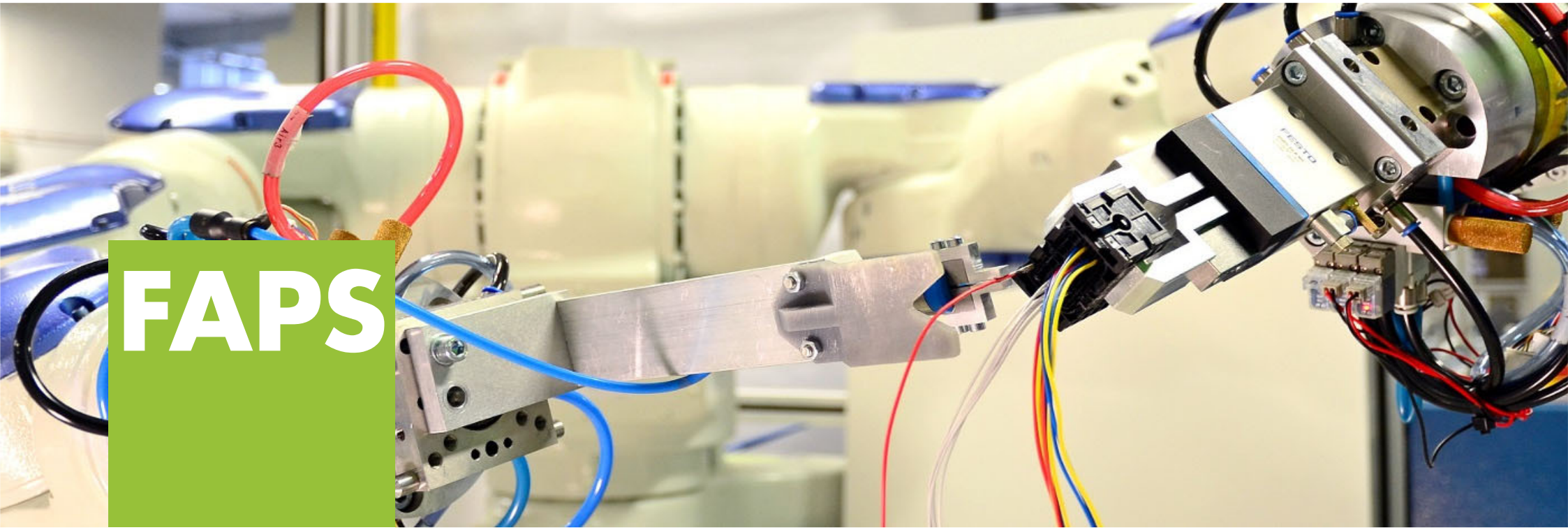

DANKE

Prof. Dr.-Ing. Jörg Franke

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