Sales presentation, as of 10.2025

Bosch Manufacturing Solutions | BMG

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BMG | **who we are**

Bosch Manufacturing Solutions | BMG –

Global industrialization partner & turnkey special machinery provider for production equipment & automation

- > 30 years of experience as special machinery supplier
- > 4.000 assembly & testing systems
  > 10.000 small & services projects
- Automation level adjustable, semi- to fully automated solutions
- Digital planning & process to digital engineering & i4.0 applications

>17
Locations

Full-liner
portfolio

Several industries & product areas

1.900
Employees

~680
TNS m€

BMG | **our purpose statement**
The difference in manufacturing

For us, **‘Invented for life’** means to build a **more sustainable future** through production equipment by Bosch Manufacturing Solutions.

We create a difference in our customers’ products by offering **“the difference in manufacturing”**

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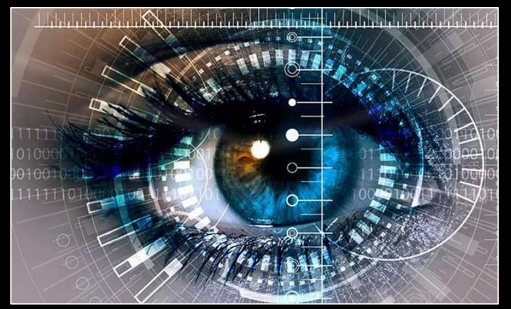
BMG | **our portfolio**
Customized assembly & testing systems

Global industrialization partner & turnkey special machinery provider for production equipment & automation, offering

Customized assembly & testing systems

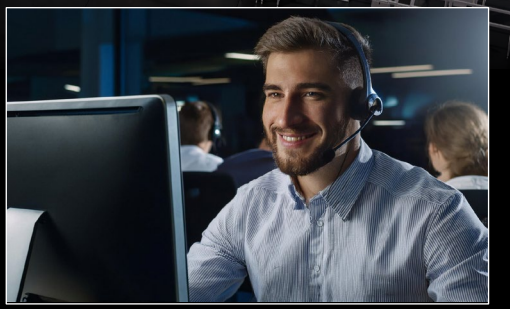
empowered by ...



Engineering Consulting & Digital Engineering

Advanced Manufacturing Processes & Technologies

Digital & Intelligent Solutions



Services along the entire product lifecycle

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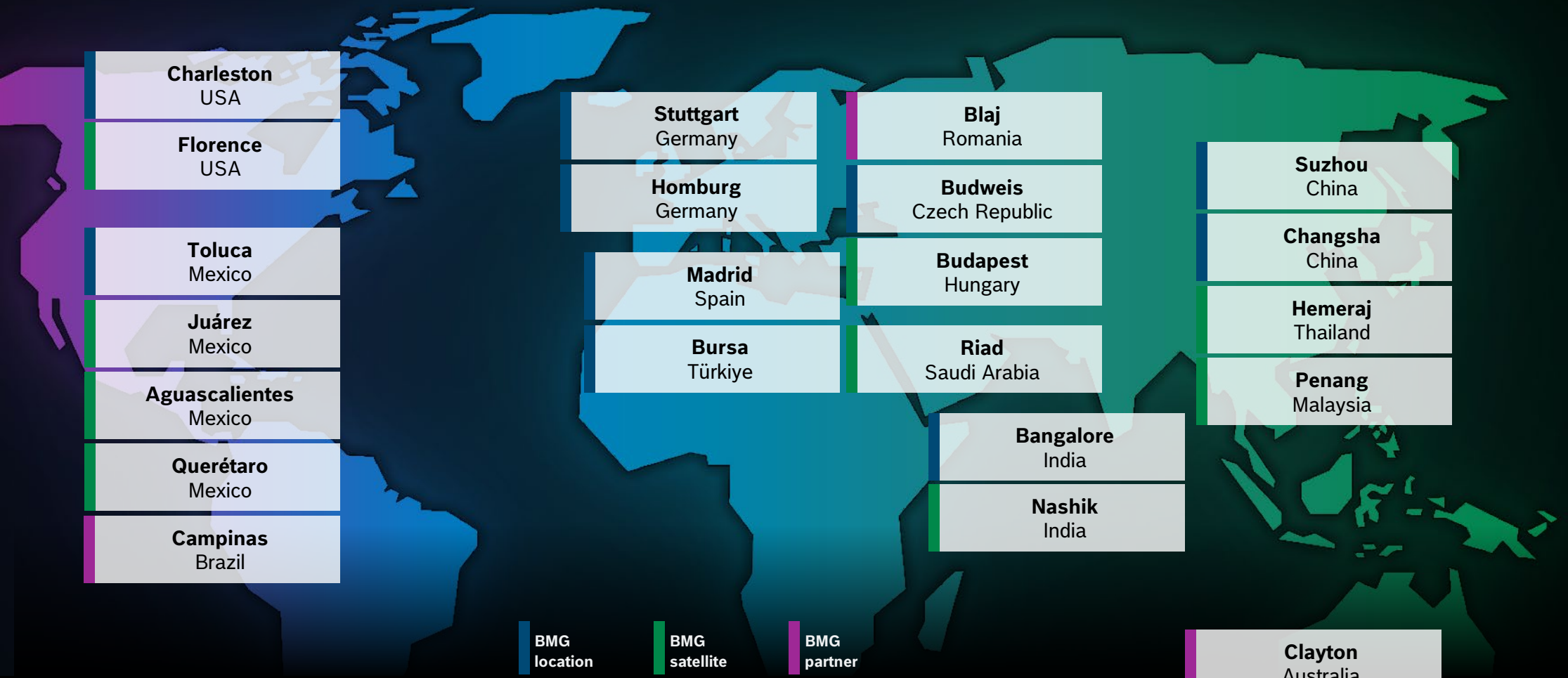
BMG | **global strength in network & partners**



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BMG | **focus industries & product areas**

Focus industries


eMobility

Automotive (ICE)


Energy

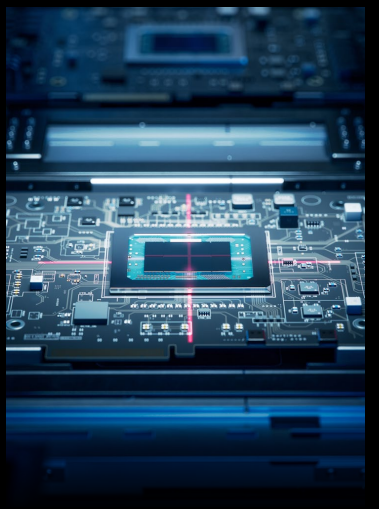

Consumer Goods

Focus product areas

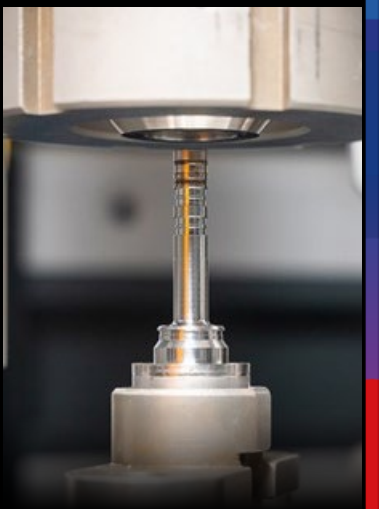

Battery


H2 Solutions / Fuel Cell


eDrive


Sensors & Electronics


Chassis & Steering


Combustion Engine

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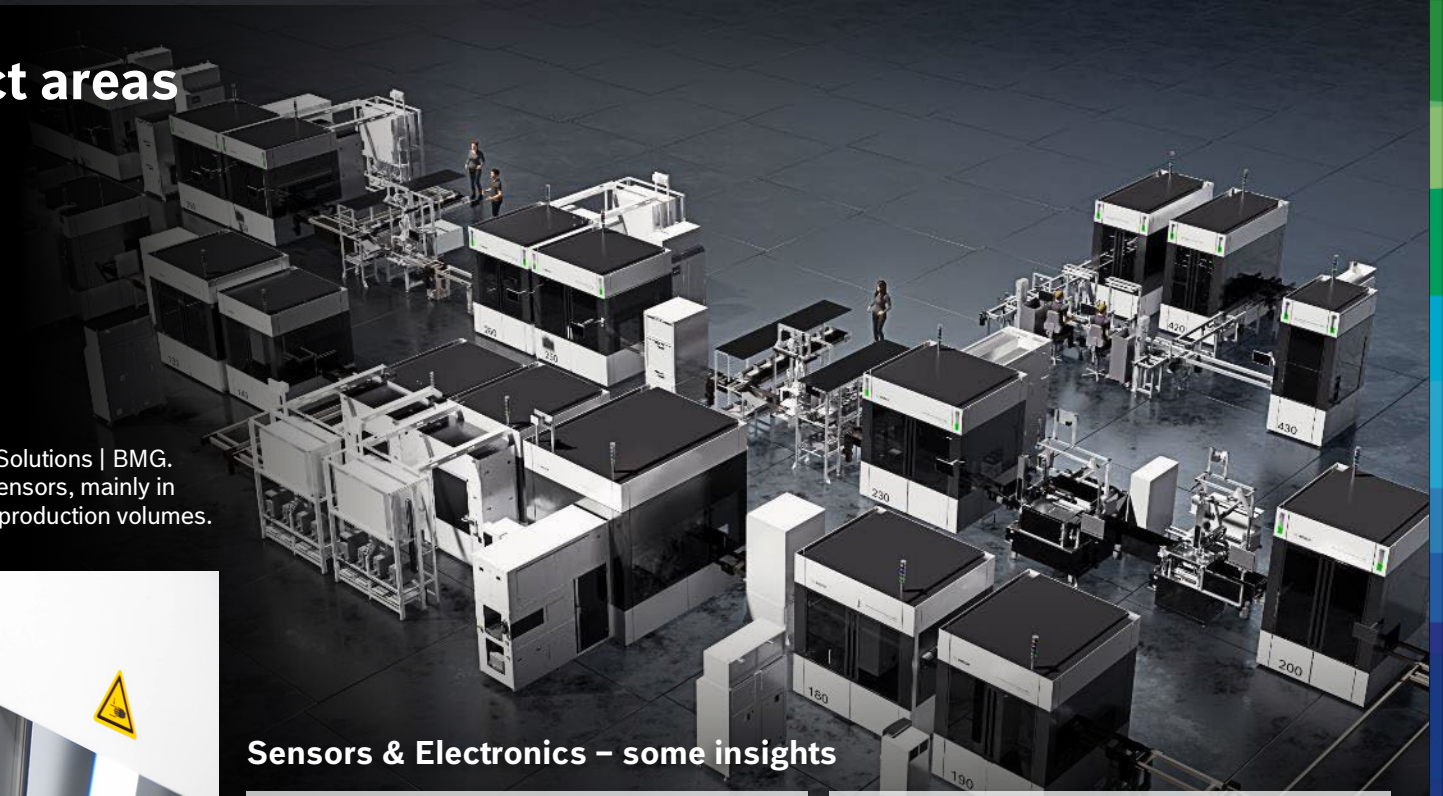
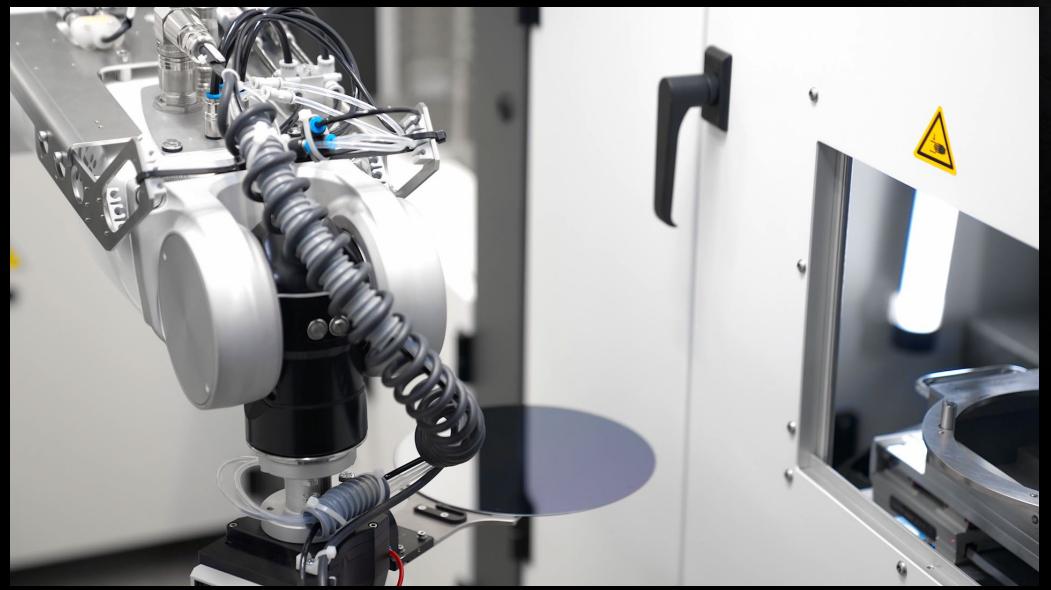
BMG | **focus industries & product areas**
Sensors & Electronics



Unleash power

with sensors & electronics production equipment from Bosch Manufacturing Solutions | BMG. We provide flexible assembly technology for ECUs, power electronics, and sensors, mainly in eMobility. Our scalable solutions optimize investments and adapt to variable production volumes.



Sensors & Electronics – some insights

Dispensing	**Screwing**
Laser Welding of Electrical Connections	**Pressfit & Single Pin Insertion**
Laser Micro Structuring	**Optical Inspection**
Laser Cleaning	**Flexfoil Handling**

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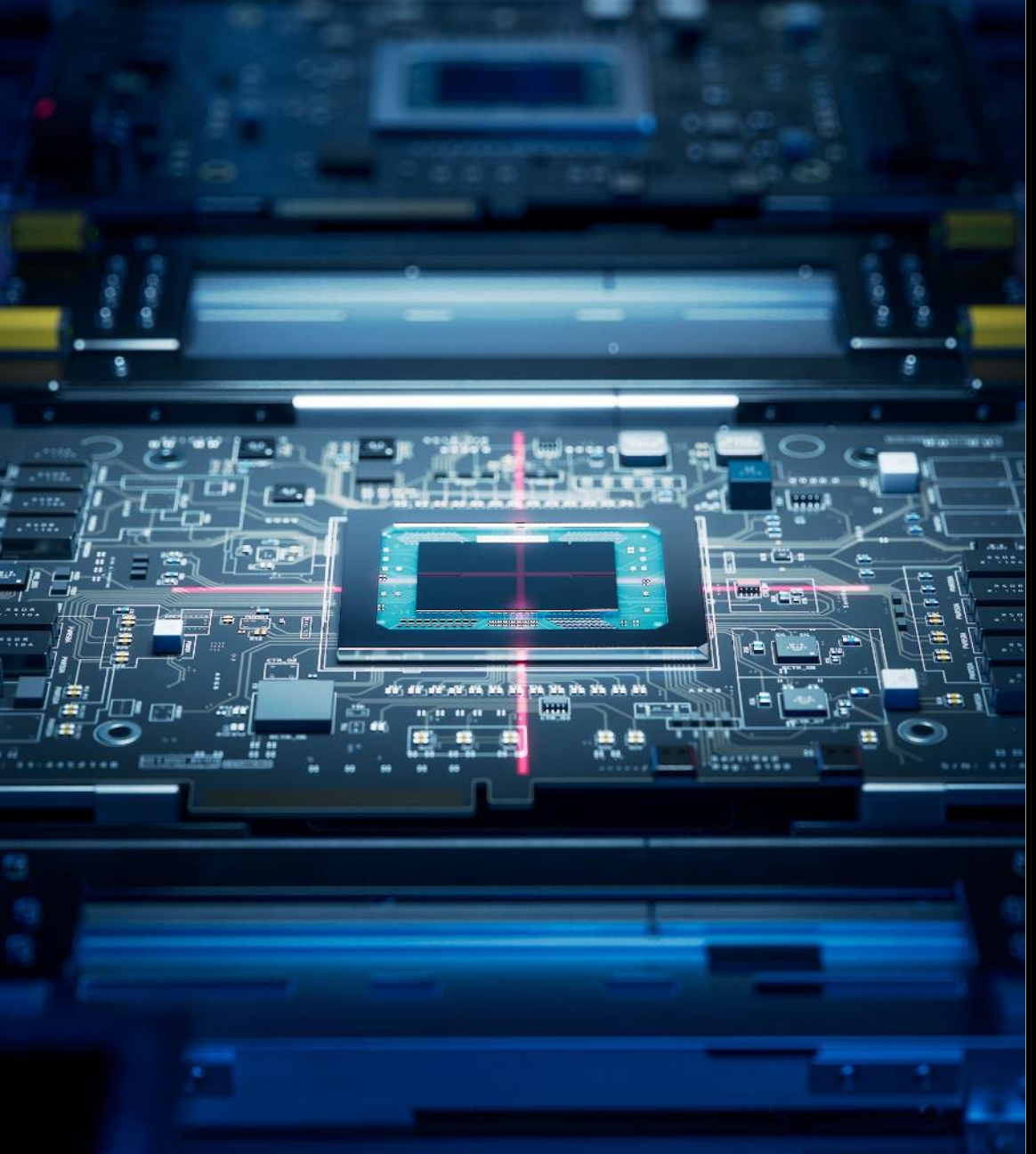

BMG | **Sensors & Electronics**

Benefits at a glance

- Over 20 years of experience in production equipment & special processes for ECUs, sensors & semiconductors
- More than 100 assembly lines running worldwide e.g. for power electronics, motor ECUs, ultrasonic & radar sensors
- Highly flexible lines in terms of type variants, automation level & volume scalability
- Short cycle times down to 4 seconds
- Global services network with qualified experts in Europe, Asia & Americas

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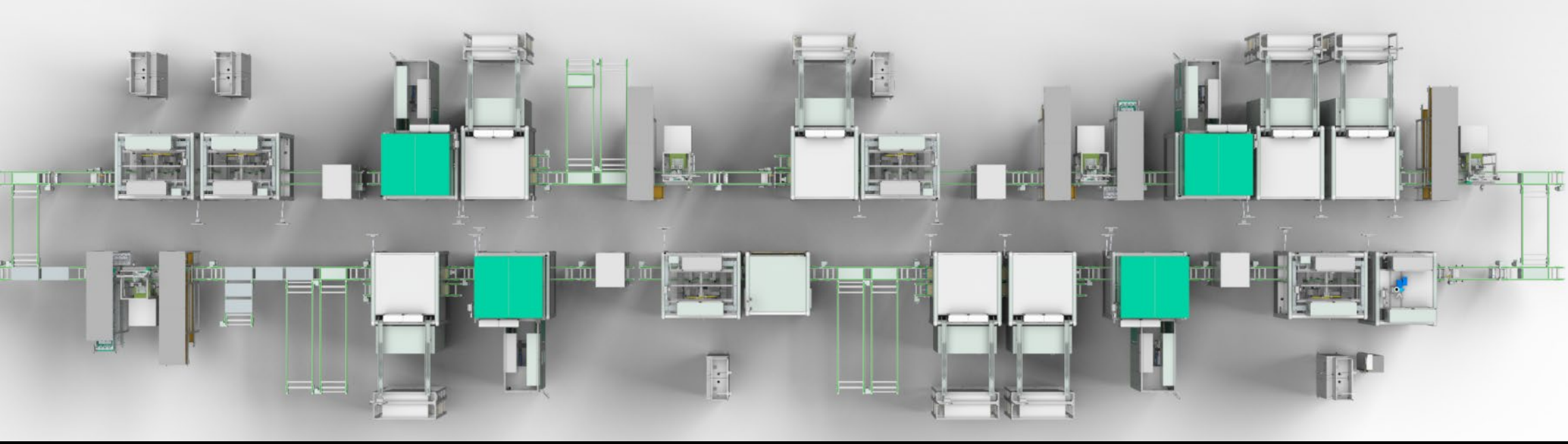

BMG | Sensors & Electronics | reference projects | **inverter production line**

Scope:
Core assembly
Final assembly
Total of 38 stations

Key technologies:
Assembly, dispensing, AOI, tightening, flexfoil handling, laser & plasma treatment

Involved BMG locations:
Germany, Spain & Turkey

Cycle time:
36 sec

Type variants:
2+

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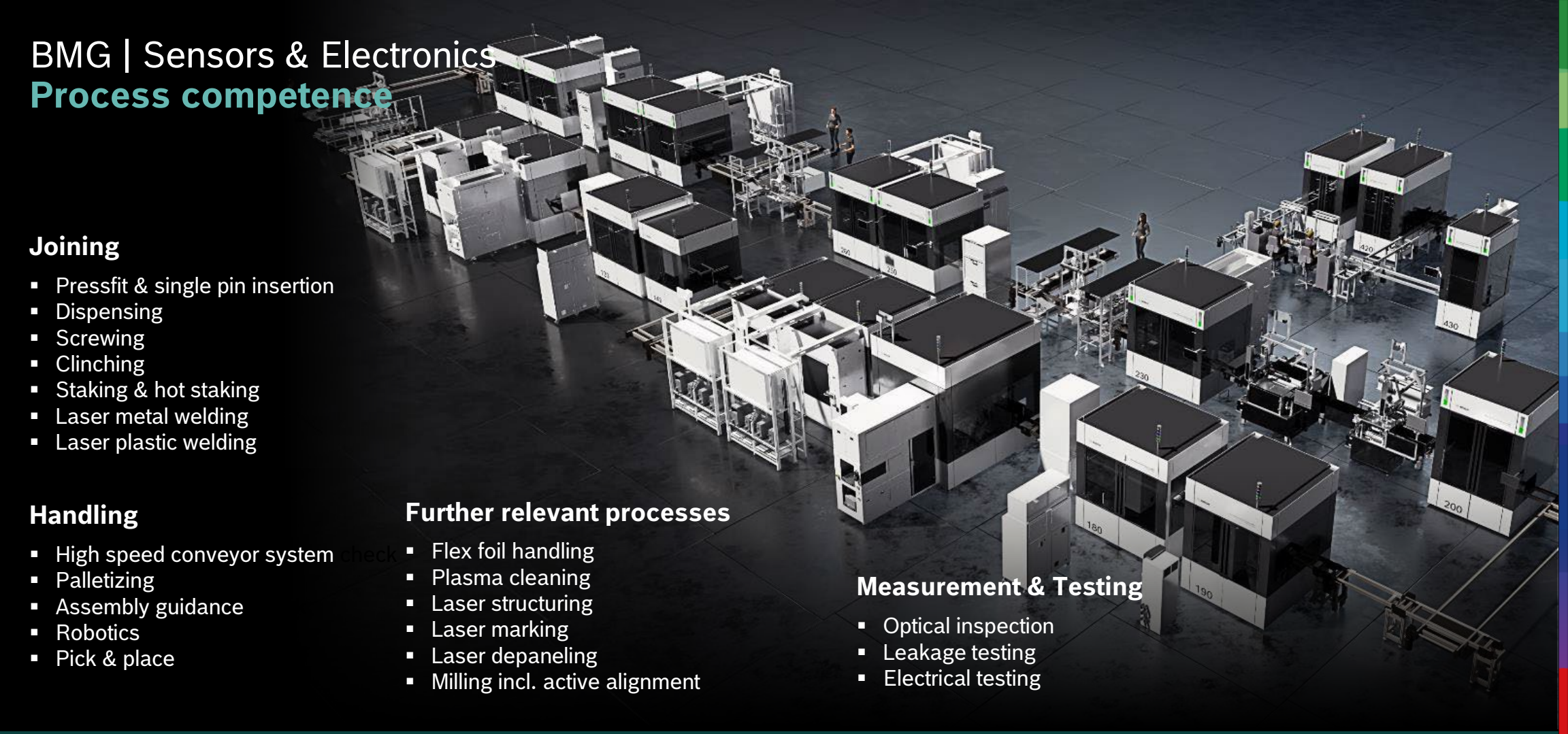
Process competence



Joining
- Pressfit & single pin insertion
- Dispensing
- Screwing
- Clinching
- Staking & hot staking
- Laser metal welding
- Laser plastic welding

Handling
- High speed conveyor system
- Palletizing
- Assembly guidance
- Robotics
- Pick & place

Further relevant processes
- Flex foil handling
- Plasma cleaning
- Laser structuring
- Laser marking
- Laser depaneling
- Milling incl. active alignment

Measurement & Testing
- Optical inspection
- Leakage testing
- Electrical testing

System integration & integrated processes from individual assembly and testing solutions to complete lines

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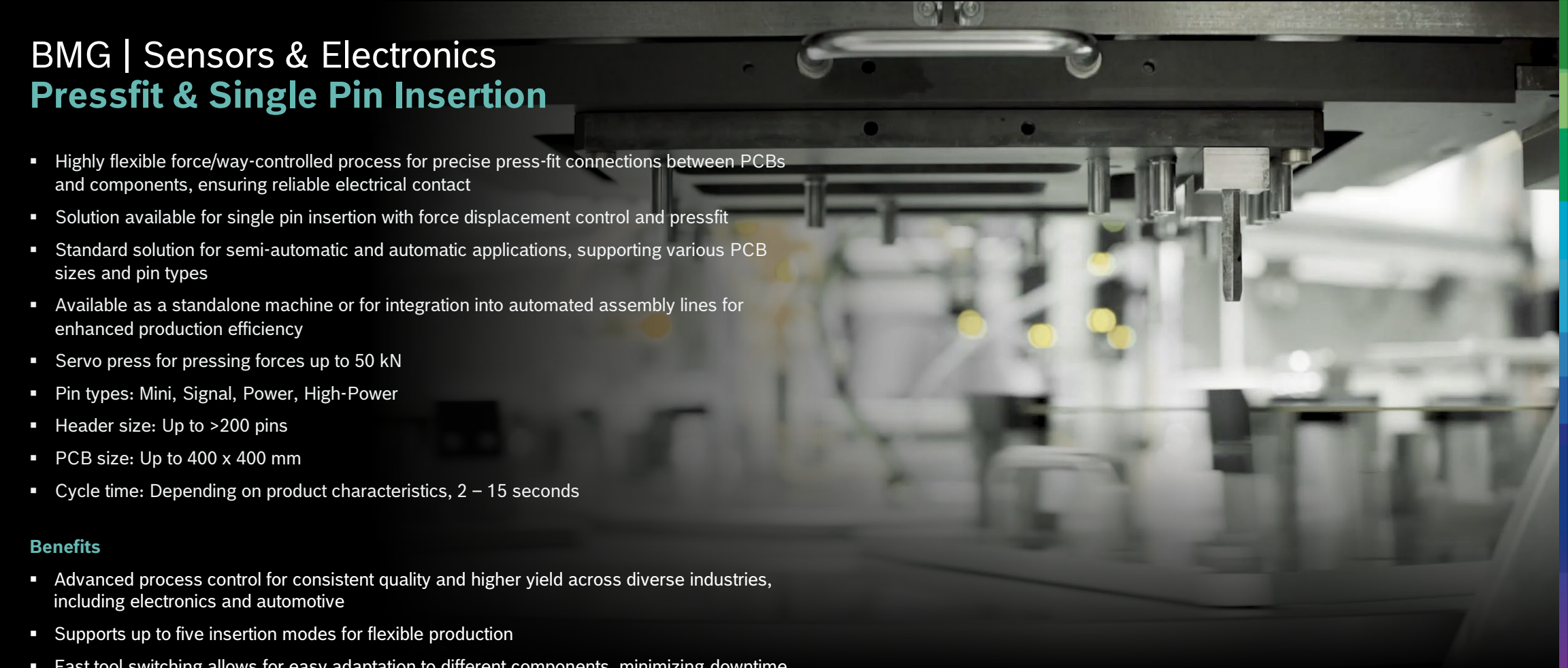
Pressfit & Single Pin Insertion



- Highly flexible force/way-controlled process for precise press-fit connections between PCBs and components, ensuring reliable electrical contact
- Solution available for single pin insertion with force displacement control and pressfit
- Standard solution for semi-automatic and automatic applications, supporting various PCB sizes and pin types
- Available as a standalone machine or for integration into automated assembly lines for enhanced production efficiency
- Servo press for pressing forces up to 50 kN
- Pin types: Mini, Signal, Power, High-Power
- Header size: Up to >200 pins
- PCB size: Up to 400 x 400 mm
- Cycle time: Depending on product characteristics, 2 – 15 seconds

Benefits

- Advanced process control for consistent quality and higher yield across diverse industries, including electronics and automotive
- Supports up to five insertion modes for flexible production
- Fast tool switching allows for easy adaptation to different components, minimizing downtime
- Integrated vision control reduces errors and optimizes production
- Scalable design enables stepwise investment from manual to automated systems, supporting future expansion
- Remote control capability improves efficiency by reducing the need for on-site intervention

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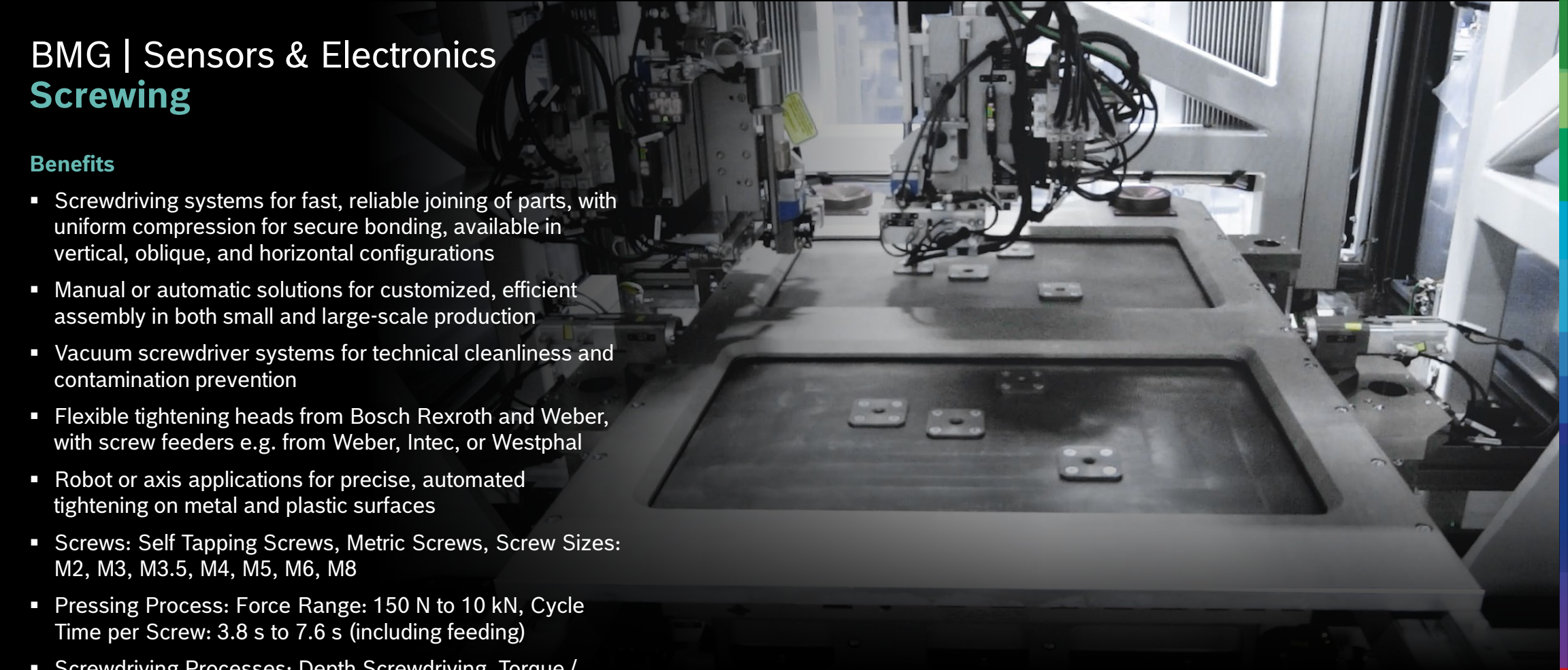
Screwing



Benefits

- Screwdriving systems for fast, reliable joining of parts, with uniform compression for secure bonding, available in vertical, oblique, and horizontal configurations
- Manual or automatic solutions for customized, efficient assembly in both small and large-scale production
- Vacuum screwdriver systems for technical cleanliness and contamination prevention
- Flexible tightening heads from Bosch Rexroth and Weber, with screw feeders e.g. from Weber, Intec, or Westphal
- Robot or axis applications for precise, automated tightening on metal and plastic surfaces
- Screws: Self Tapping Screws, Metric Screws, Screw Sizes: M2, M3, M3.5, M4, M5, M6, M8
- Pressing Process: Force Range: 150 N to 10 kN, Cycle Time per Screw: 3.8 s to 7.6 s (including feeding)
- Screwdriving Processes: Depth Screwdriving, Torque / Angle Control Screwdriving
- Pressing Processes: To Position with Force Check / to Force with Position Check

BMG | Sensors & Electronics
Handling & Robotics | Flexfoil handling

- Highly precise and technology-driven process specifically designed for handling of flexible foil materials
- Full automation of catching, guiding, and inserting flex foils or cables with integrated control for reliable insertion
- Accurate positioning using sensors for precise alignment during production
- Vacuum grippers and mechanical form force for careful handling, preventing damage to delicate flex foil structures
- Cycle time minimization through maximal process knowledge
- Positioning repeatability according to ISO 9283: ± 0.02 mm
- Wide range of flex foil widths from several millimeters to centimeters
- Typical flex foil thickness between 0.175 to 0.3 mm
- Dual gripper for different connector sizes

Benefits

- Integrated sensors compensate for position and component tolerances, ensuring process reliability
- Slim robot end effector design reduces cycle time and footprint
- Teach point optimization and anomaly detection minimize downtime
- Changeable grippers increase production flexibility for various product variants

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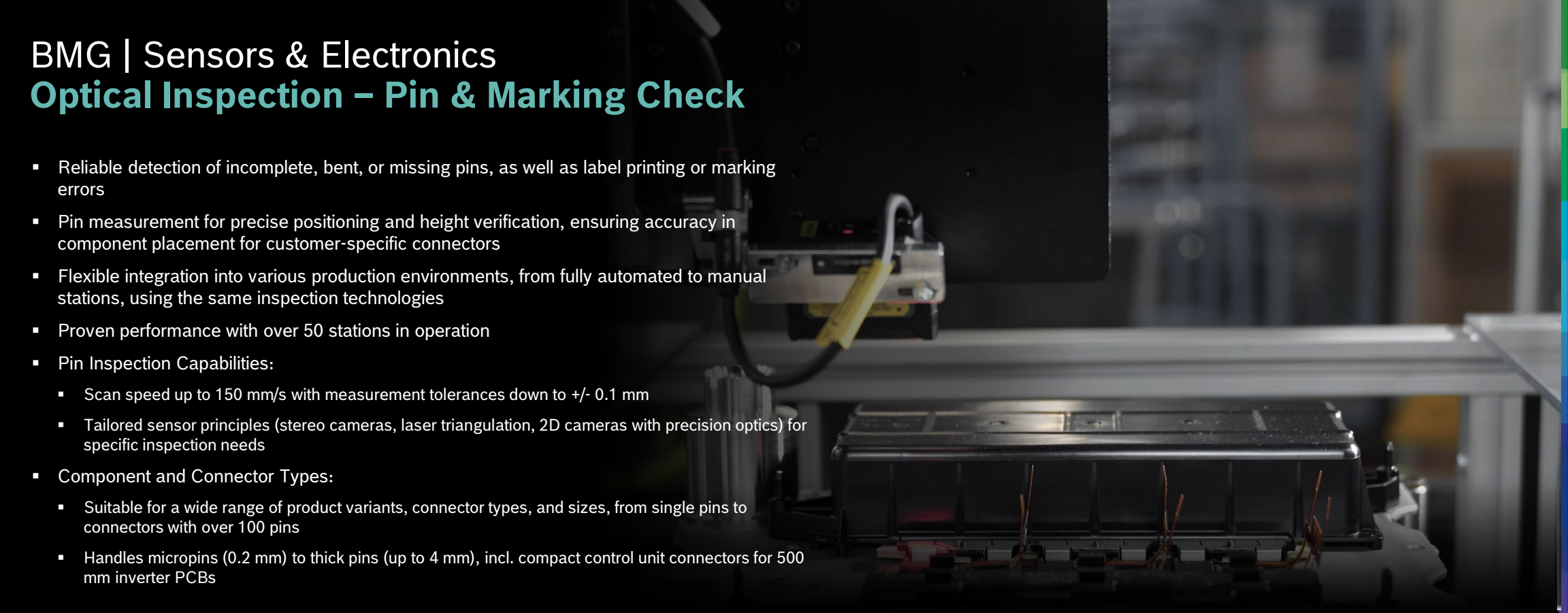
Optical Inspection – Pin & Marking Check



- Reliable detection of incomplete, bent, or missing pins, as well as label printing or marking errors
- Pin measurement for precise positioning and height verification, ensuring accuracy in component placement for customer-specific connectors
- Flexible integration into various production environments, from fully automated to manual stations, using the same inspection technologies
- Proven performance with over 50 stations in operation
- Pin Inspection Capabilities:
  - Scan speed up to 150 mm/s with measurement tolerances down to +/- 0.1 mm
  - Tailored sensor principles (stereo cameras, laser triangulation, 2D cameras with precision optics) for specific inspection needs
- Component and Connector Types:
  - Suitable for a wide range of product variants, connector types, and sizes, from single pins to connectors with over 100 pins
  - Handles micropins (0.2 mm) to thick pins (up to 4 mm), incl. compact control unit connectors for 500 mm inverter PCBs

Benefits

- 100% quality check ensures consistent product quality & compliance with automotive standards
- High transparency of inspection decision through real-time visualization enables effective monitoring and quicker issue identification
- Easy adaptation of inspection processes via user-friendly software platform
- MES integration: seamless data exchange for real-time tracking & optimized production control

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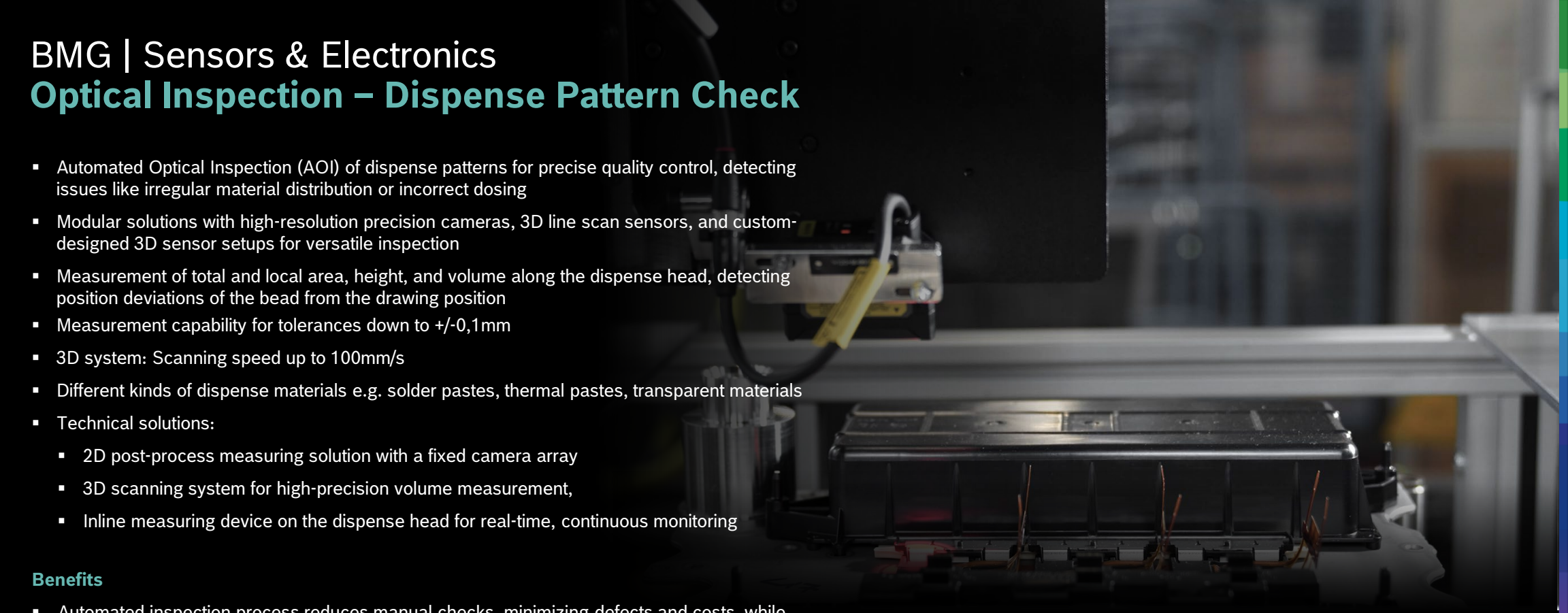
Optical Inspection – Dispense Pattern Check



- Automated Optical Inspection (AOI) of dispense patterns for precise quality control, detecting issues like irregular material distribution or incorrect dosing
- Modular solutions with high-resolution precision cameras, 3D line scan sensors, and custom-designed 3D sensor setups for versatile inspection
- Measurement of total and local area, height, and volume along the dispense head, detecting position deviations of the bead from the drawing position
- Measurement capability for tolerances down to +/-0,1mm
- 3D system: Scanning speed up to 100mm/s
- Different kinds of dispense materials e.g. solder pastes, thermal pastes, transparent materials
- Technical solutions:
  - 2D post-process measuring solution with a fixed camera array
  - 3D scanning system for high-precision volume measurement,
  - Inline measuring device on the dispense head for real-time, continuous monitoring

Benefits

- Automated inspection process reduces manual checks, minimizing defects and costs, while enhancing efficiency and ensuring consistent quality
- Continuous process monitoring collects real-time data for production optimization and long-term quality improvements
- Customizable measurement: Tailored dispense process with customer-defined coordinates and housing geometry ensures precise alignment and superior product quality
- Flexible and scalable vision systems adapt to a wide range of dispensing materials and product types, offering versatility for diverse production needs

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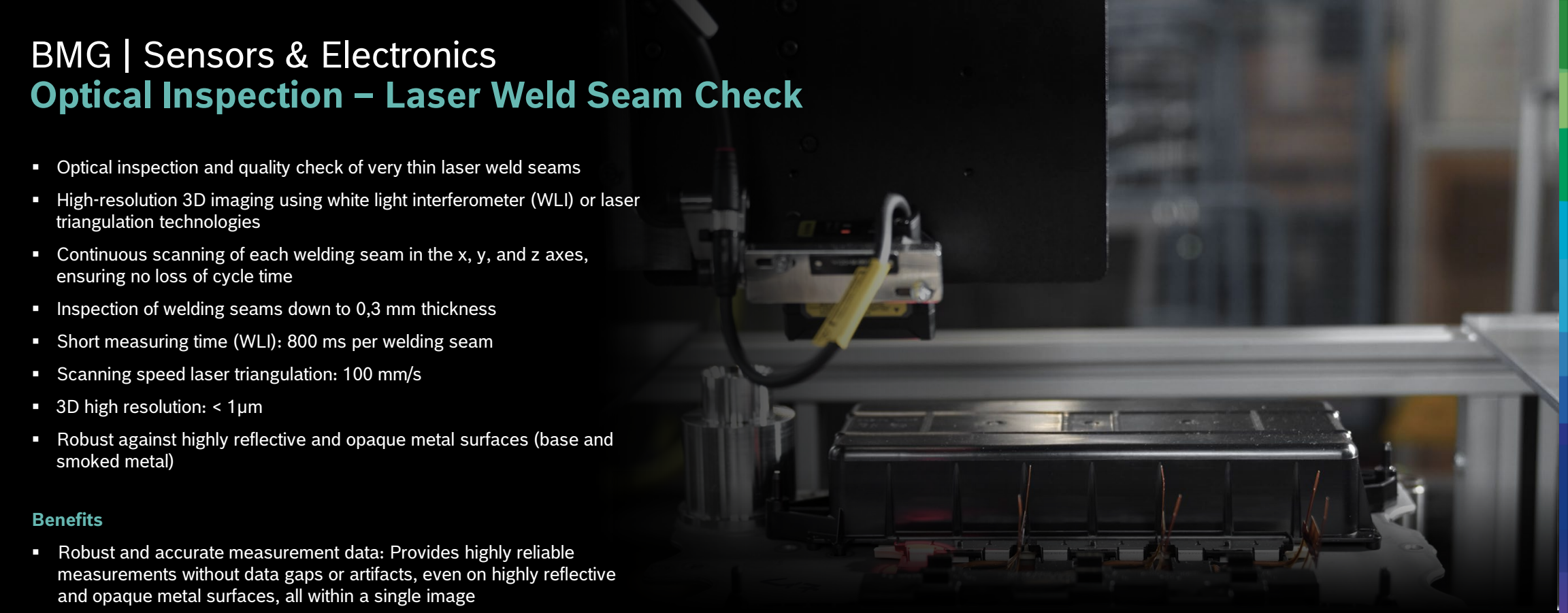
Optical Inspection – Laser Weld Seam Check



- Optical inspection and quality check of very thin laser weld seams
- High-resolution 3D imaging using white light interferometer (WLI) or laser triangulation technologies
- Continuous scanning of each welding seam in the x, y, and z axes, ensuring no loss of cycle time
- Inspection of welding seams down to 0,3 mm thickness
- Short measuring time (WLI): 800 ms per welding seam
- Scanning speed laser triangulation: 100 mm/s
- 3D high resolution: < 1µm
- Robust against highly reflective and opaque metal surfaces (base and smoked metal)

Benefits

- Robust and accurate measurement data: Provides highly reliable measurements without data gaps or artifacts, even on highly reflective and opaque metal surfaces, all within a single image
- Precise evaluation of welding quality, ensuring consistent quality control
- Seamless integration into production lines: The system supports the integration of sub-micron measurement capabilities into series production, enhancing efficiency and overall quality management

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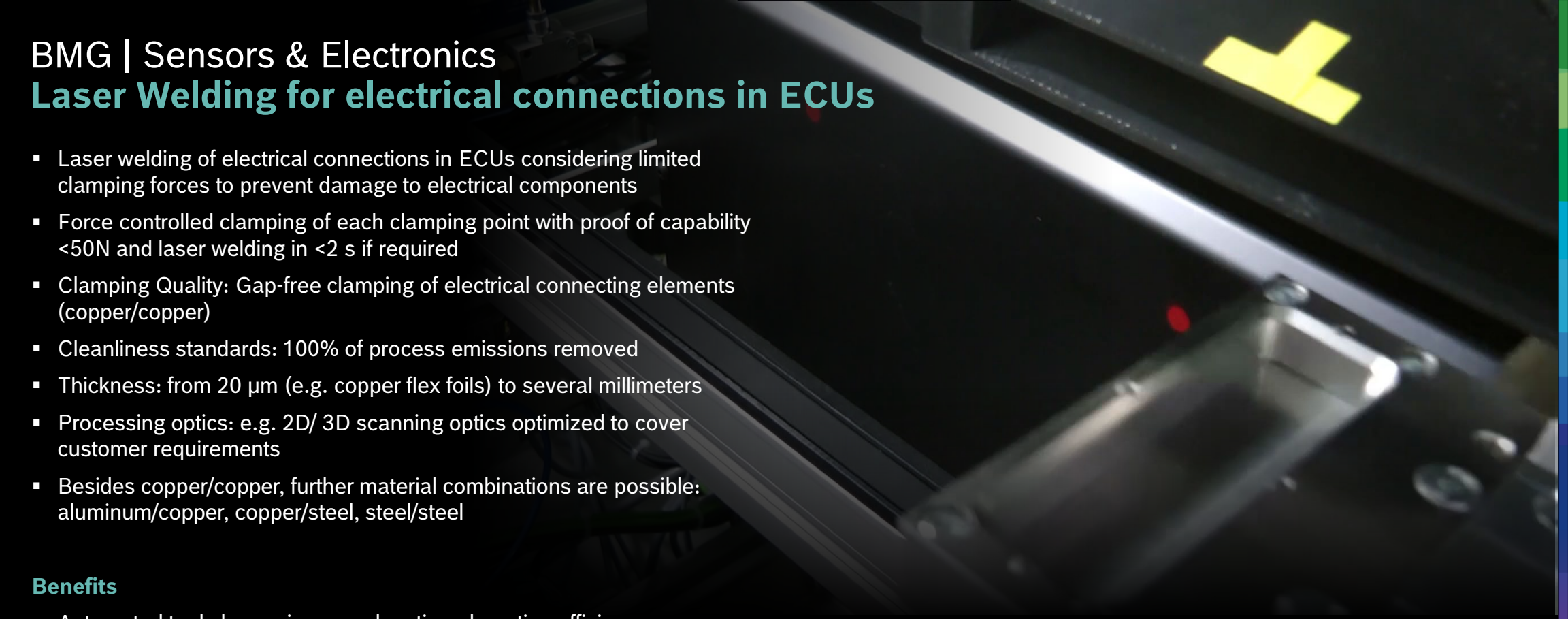
Laser Welding for electrical connections in ECUs



- Laser welding of electrical connections in ECUs considering limited clamping forces to prevent damage to electrical components
- Force controlled clamping of each clamping point with proof of capability <50N and laser welding in <2 s if required
- Clamping Quality: Gap-free clamping of electrical connecting elements (copper/copper)
- Cleanliness standards: 100% of process emissions removed
- Thickness: from 20 µm (e.g. copper flex foils) to several millimeters
- Processing optics: e.g. 2D/ 3D scanning optics optimized to cover customer requirements
- Besides copper/copper, further material combinations are possible: aluminum/copper, copper/steel, steel/steel

Benefits

- Automated tool change in secondary time, boosting efficiency
- Unique welding process ensuring maximum cleanliness and minimal contamination
- Determination of the ideal welding position if required to increase quality
- Quality assessment system with AI functionality

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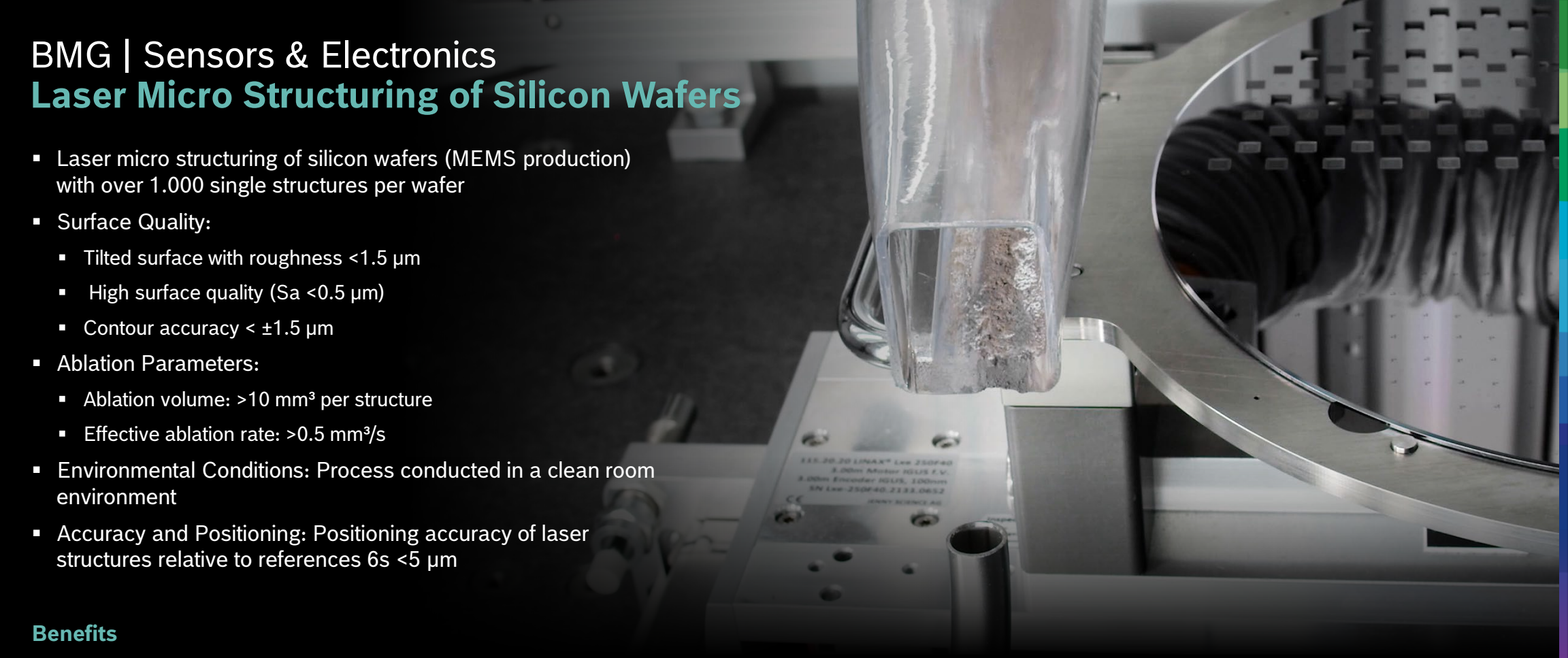
Laser Micro Structuring of Silicon Wafers



- Laser micro structuring of silicon wafers (MEMS production) with over 1.000 single structures per wafer
- Surface Quality:
  - Tilted surface with roughness <1.5 µm
  - High surface quality (Sa <0.5 µm)
  - Contour accuracy < ±1.5 µm
- Ablation Parameters:
  - Ablation volume: >10 mm³ per structure
  - Effective ablation rate: >0.5 mm³/s
- Environmental Conditions: Process conducted in a clean room environment
- Accuracy and Positioning: Positioning accuracy of laser structures relative to references 6s <5 µm

Benefits

- Two-laser multistage process combines high-volume nanosecond ablation and high-precision ultra short pulsed laser finishing for fast, high-quality results
- Automated 3D measurement and ablation pattern calculation ensure precise, repeatable results and reduce scrap rate

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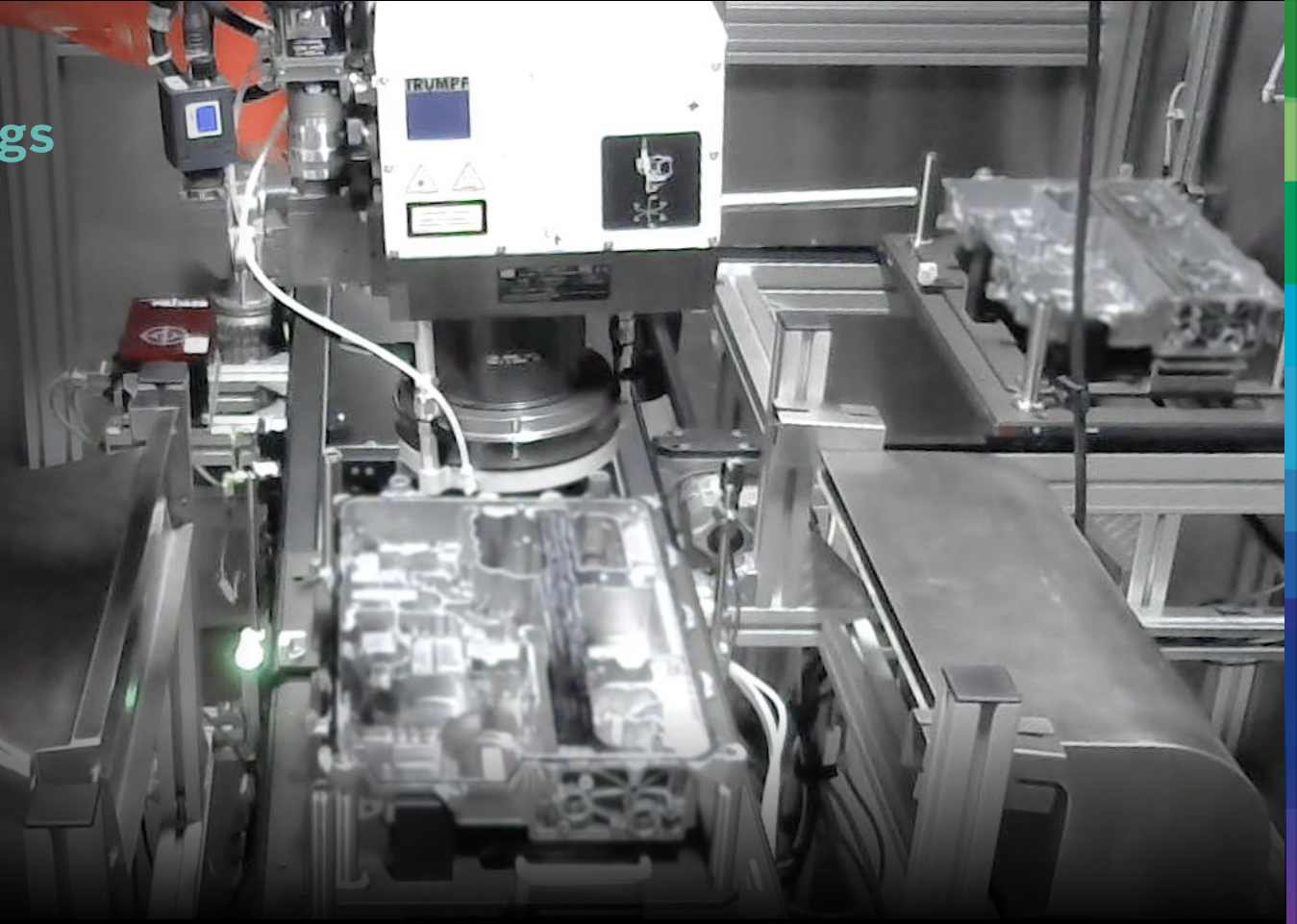
Laser cleaning of Aluminum Housings for control units



- Short pulse laser treatment for cleaning and functional surface preparation
- Application: Robot-guided laser cleaning process of die cast aluminum 3D surfaces as preparation before dispensing process
- Combination of laser cleaning and laser polishing process
- Advanced suction devices for removing 100% of process emission

Benefits

- Surface to be cleaned up to 800 mm x 800 mm
- Short pulse laser treatment up to 30 cm²/s with oxide layer removal / regrowth
- Up to 100 cm²/s for removal of organic contaminations
- Surface energy > 70 mN/m achievable
- RFU < 3 reachable (relative fluorescence unit)
- Increase of surface roughness possible

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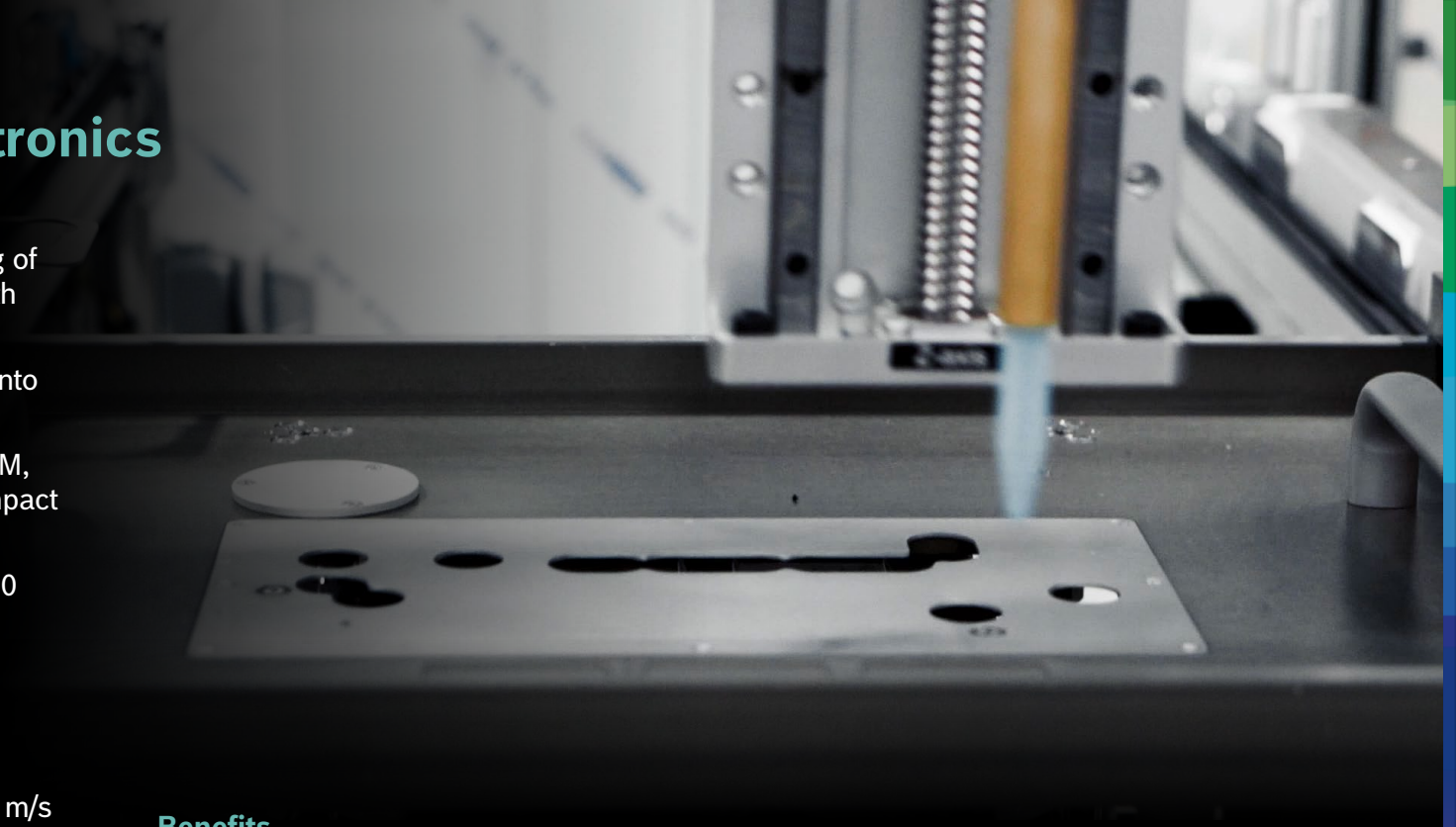
Dispensing for Sensors & Electronics



- Development and machinery for high-precision dispensing of 1C and 2C materials (adhesives, TIM, sealing, potting) with full process control
- Integration of dosing technologies from leading suppliers into a single machine control system for seamless operation
- Wide range of dispensing heads for application of glue, TIM, and sealing materials, with optimized cycle times and compact design
- Work piece carrier size: from 160 x160 mm up to 640 x 400 mm (or customized)
- Precise dispensing from 20 mg to > 2 kg of low & highly viscous materials
- Precise dynamic positioning repeatability of +/-0.2 mm
- High dynamic movements with linear driven axis up to 1.5 m/s
- Integrated 2D/3D AOI system
- Automatic fast changing of dispensing masks for up to 9 different masks possible
- High precision SPC equipment – scale up to 0.1 mg resolution, needle measurement with 0,01 mm repeatability
- Flexibility: 10 types of dispensing heads, 8 types of material supplies in 5 types of standard cells applied so far

Benefits

- Proven reliability in product quality, precision, tightness, and thermal stability with over 200 dispensing stations delivered in 5 years
- High standardization for short lead times and reduced costs, with a single machine and control system for all applications
- Easy changeovers with interruption-free material
- Optimized footprint with integrated control cabinets and transfer units

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