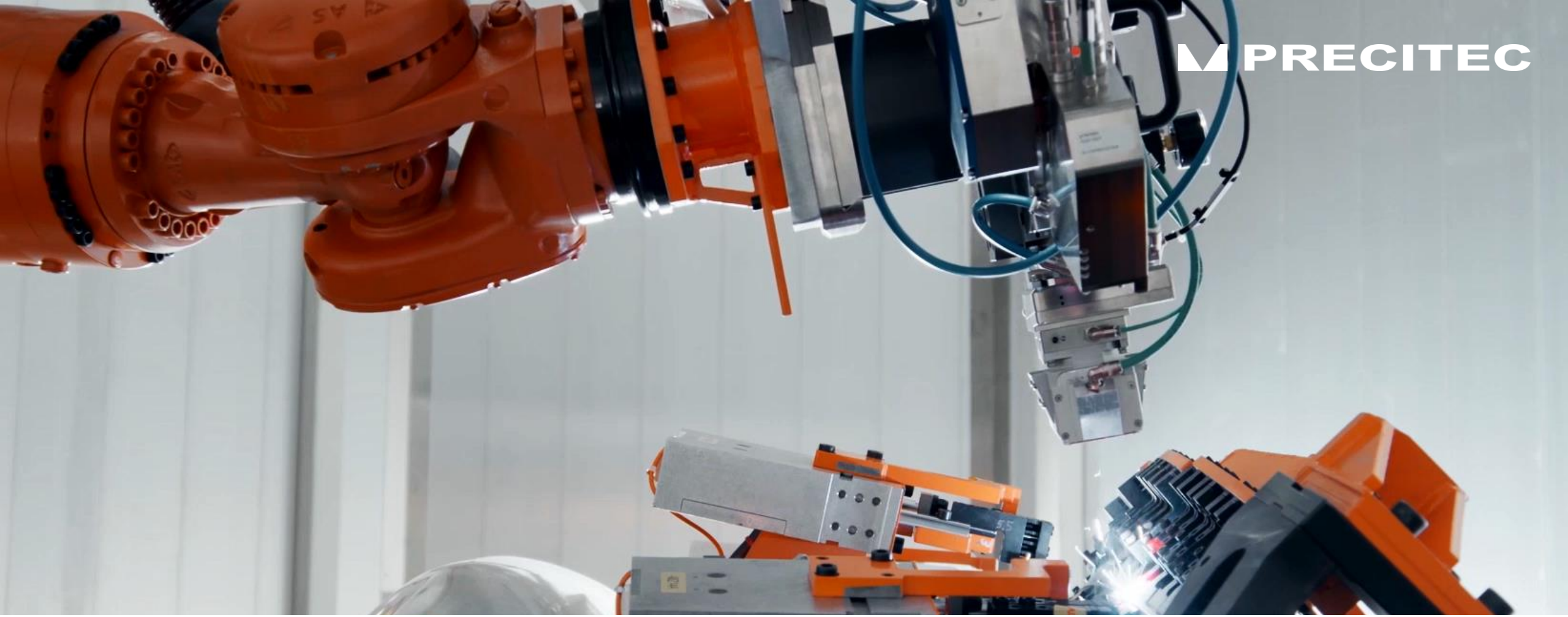


THE CHALLENGES OF LASER WELDING IN E-MOBILITY – ACHIEVING GUARANTEED QUALITY WITH SOPHISTICATED SYSTEM TECHNOLOGY

February 19th, 2024 | Dr. Markus Kogel-Hollacher (R&D Projects)

WORLDWIDE SUPPORT

500 Employees

Gaggenau

New-Isenburg

Karlsruhe

250 Employees

Shanghai, Peking,

Shenzhen, Suzhou,

Hongkong

Chateauneuf-le-Rouge

Arcueil (Enovasense)

PRODUCTION SITES

Wixom / MI

Santa Clara / CA

Switzerland

Japan

Korea

Taiwan

India

FACTS & FIGURES

RESEARCH AND DEVELOPMENT

14% R&D invest p.a. as percentage of turnover
245 Patents

INNOVATION AND MARKET LEADER

in the key areas of Laser Technology
and 3D Metrology

MARKET PRESENCE AND GROWTH

22 Countries | Growth rate: 17% Ø growth rate
Sales 160 mio. € in 2021
750 employees

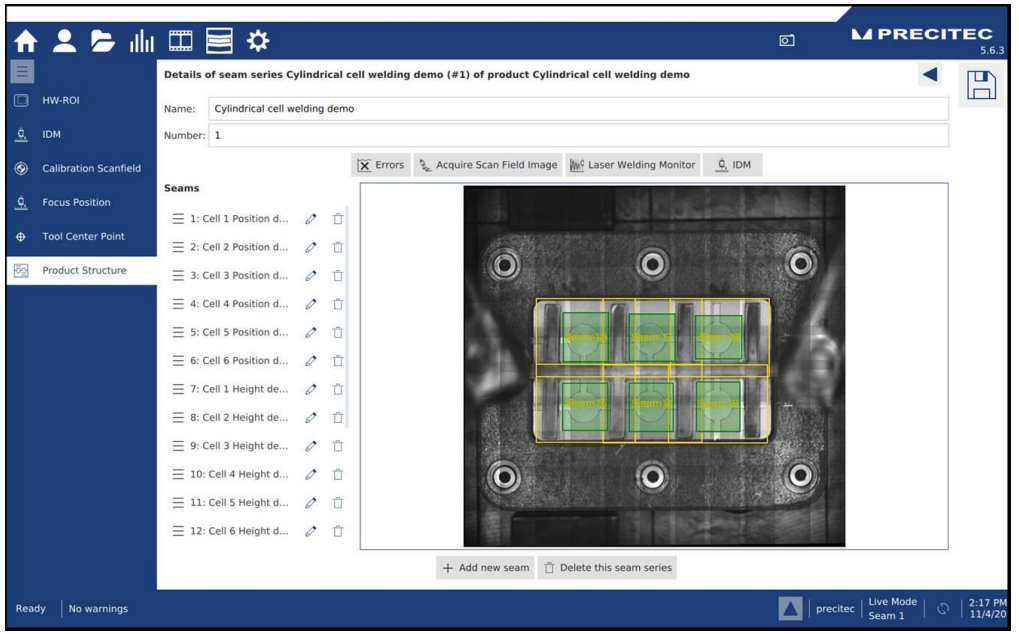
FAMILY OWNED COMPANY

independent

PRECITEC SCANMASTER

One-Stop-Solution

- All-In-One 2.5D scanner
  - Precitec Pre-, In-, Post-Process systems
  - One GUI for everything
- Pre-Process control
  - Fast and precise part position detection (x, y and z)
    - Camera vision system (x, y)
    - OCT/FocusFinder (z)
    - Fast motorized z-collimation ensures autofocus
- In-Process monitoring
  - Process monitoring and long term traceability
    - Laser Welding Monitor (LWM)
    - Laser Power Monitor (LPM)
- Post-Process inspection
  - Gray scale image processing (camera)



Precitec ScanMaster

PRECITEC SCANMASTER – RELIABLE TECHNOLOGY

Industrial scanner

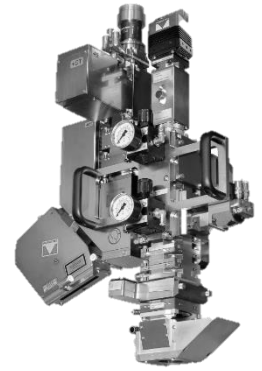
- > 3.500 units in field

Motorized collimator

- ProCutter technology
- > 15.000 units in field

All-In-One Packages

- Experienced based on WeldMaster
- > 300 WeldMaster systems in field



Quality Monitoring

- Photo diode based
- > 10.000 LWM systems sold

Vision System

- Camera based
- > 1.000 units in field

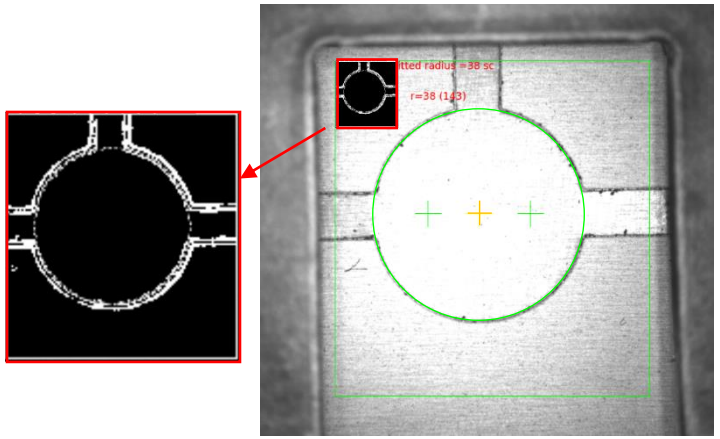
ScanMaster

PRECITEC

PRECITEC SCANMASTER

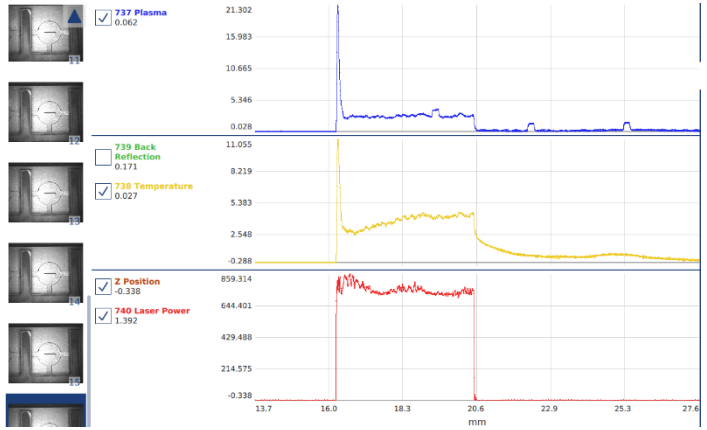
Pre-Process

- Part position detection
  - Vision
  - Distance measurment
  - Correction Δ x,y and z



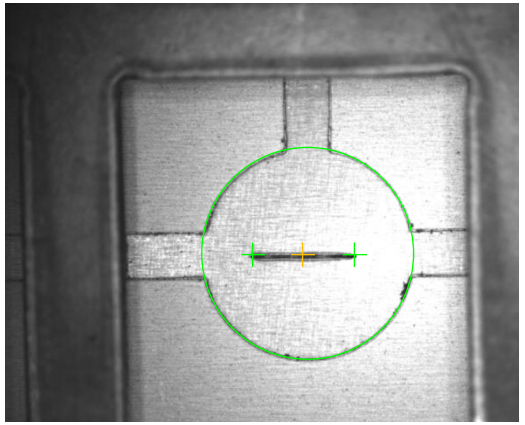
In-Process

- Monitoring
  - Laser Welding Monitor
  - Laser Power Monitor
- Motorized collimation

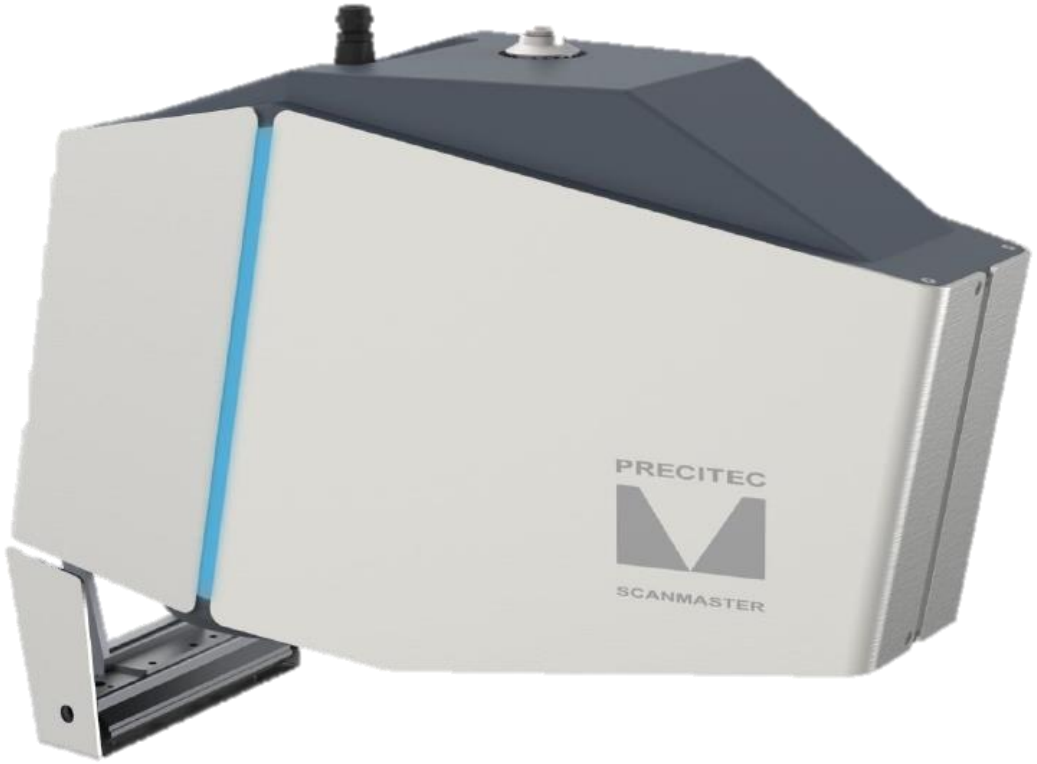


Post-Process

- Gray scale image
  - Seam geometry
- Post surface inspection
  - Photo diode based



PRECITEC SCANMASTER



Design study 2025

Technical specifications

- Laser wavelength: 1030 nm – 1080 nm *
- Laser power: up to 8.000 W cw *
- Collimation focusing length: 100/125/150/175/200mm *
- Focusing focal length: 255/340/460 mm *
- F-Theta lens working distance 300-480 mm
- Scan area elliptical 220x104mm / 400x300mm *
- Z stroke: +/- 35mm (FF 340)
- Dimensions: 600mm x 220mm x 500mm
- Weight: app. 25kg
- * more configurations on request

PRECITEC SCANMASTER + CAILABS CANUNDA-HP

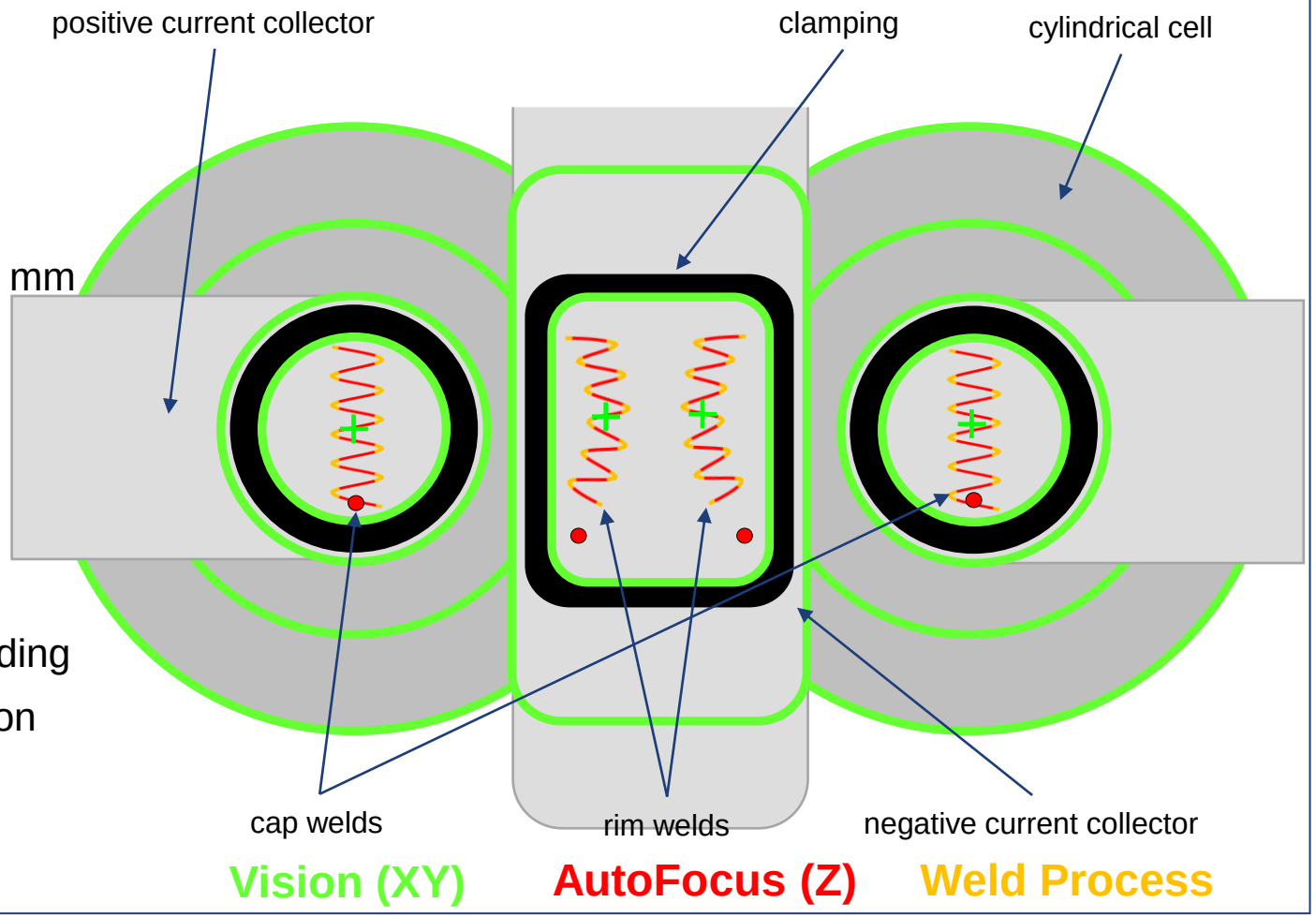
Key-performances of CANUNDA-HP

- Quality beam shaping
  - 99% system transmission
  - Maximal focus shift of 1 mm
  - 6% RMS homogeneity around the ring
- An industrial solution
  - Compatible with robot welding arms and very
  - high-power lasers (16 kW)
  - Fast installation: no adjustments or alignment needed
- For an improved process
  - Excellent depth of field (+/-3 mm)
  - Very good joint width and smooth keyhole

CELL CONTACTING: ADVANTAGE OF VISION SYSTEM

XY position detection and correction

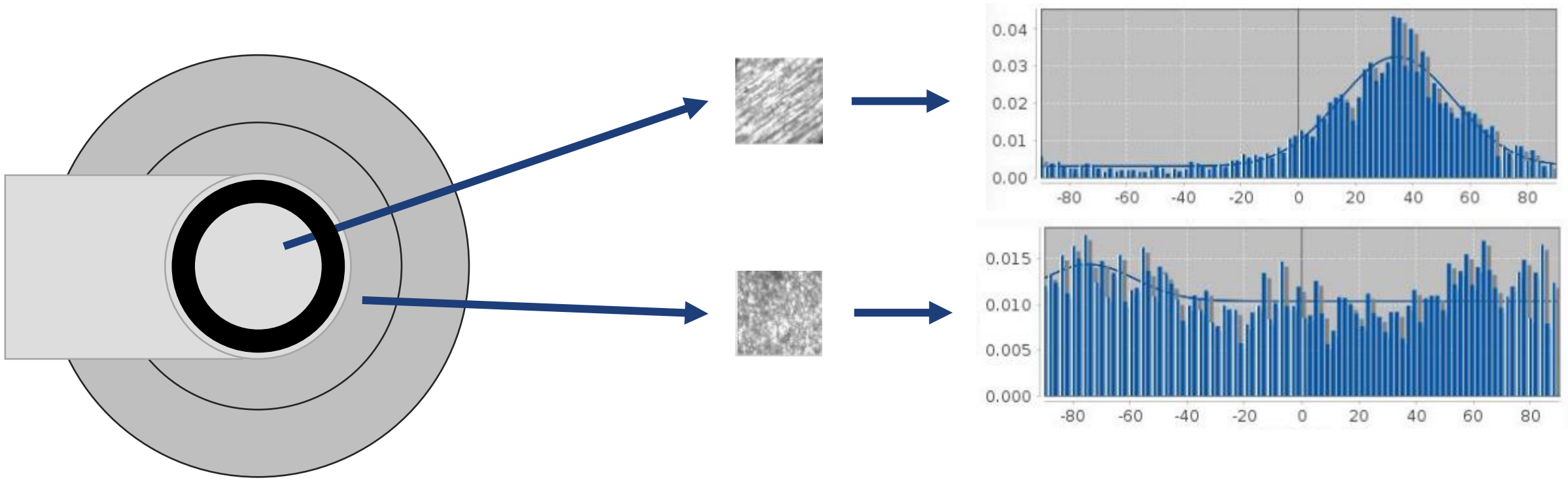
- Process limitations
  - Gap bridge ability small
  - Clamp position
- Product limitations
  - Variation of plastic cell tray in x and y up to 0.5 mm
  - Limited contact surface for rim weld
- Solution for a stable process: Precitec Vision
  - High resolution feature detection in < 10 ms
- Benefits:
  - Reproducible weld position on cap and rim
  - Eliminates risk of damaging clamps during welding
  - Compensation and reporting of cell tray variation



QUANTIFICATION VISION SYSTEM

Plausibility check after clamping

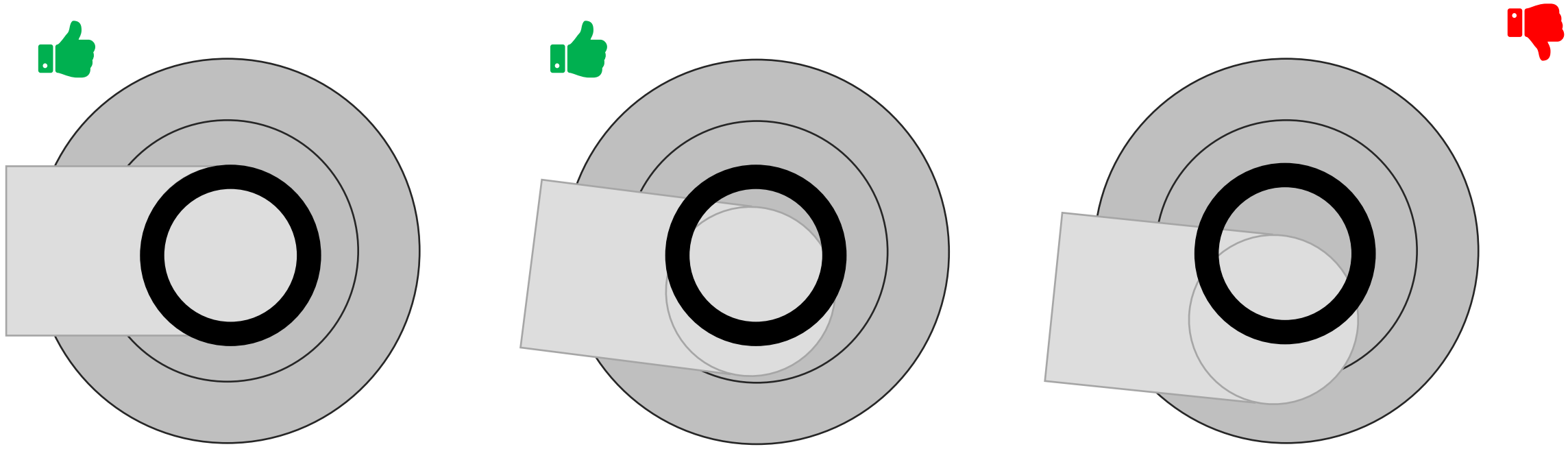
- Texture based analysis of pad presence after clamping



QUANTIFICATION VISION SYSTEM

Texture analysis

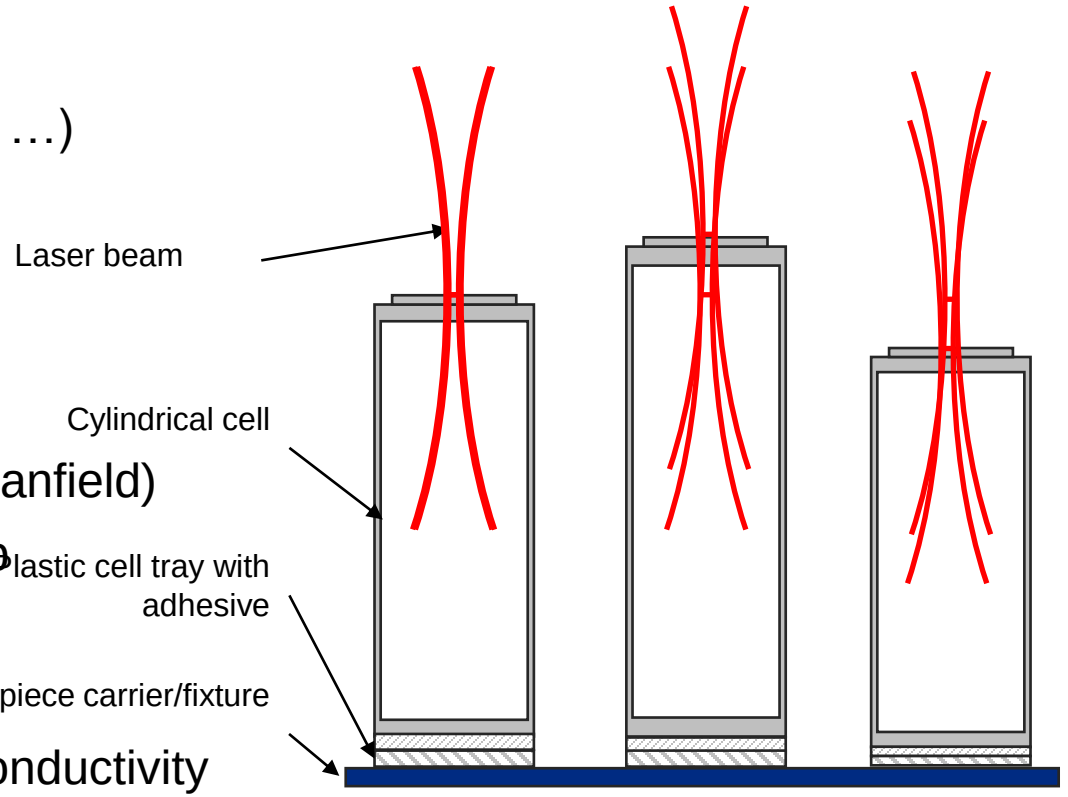
- Pad under clamp detected
  - Ratio / threshold to define OK or NOK up to customer



ADVANTAGES OF AUTOFOCUS FUNCTION

Z position detection and correction

- Process limitations
  - Usable Rayleigh length < 20% of theoretical length
  - Equipment related tolerances (workpiece carrier, fixture, …)
- Product limitations
  - Individual cell height variation (up to 500 µm)
  - Assembly related tolerances (glue, plastic frames, ...)
- Solution for a stable process: Precitec AutoFocus
  - Realtime focus position correction < 10 ms (complete scanfield)
  - Multiple measurement points possible e.g. start and stop
- Benefits:
  - Consistent penetration depth to avoid welding into cell
  - Reduced intermetallic phases and improved electrical conductivity

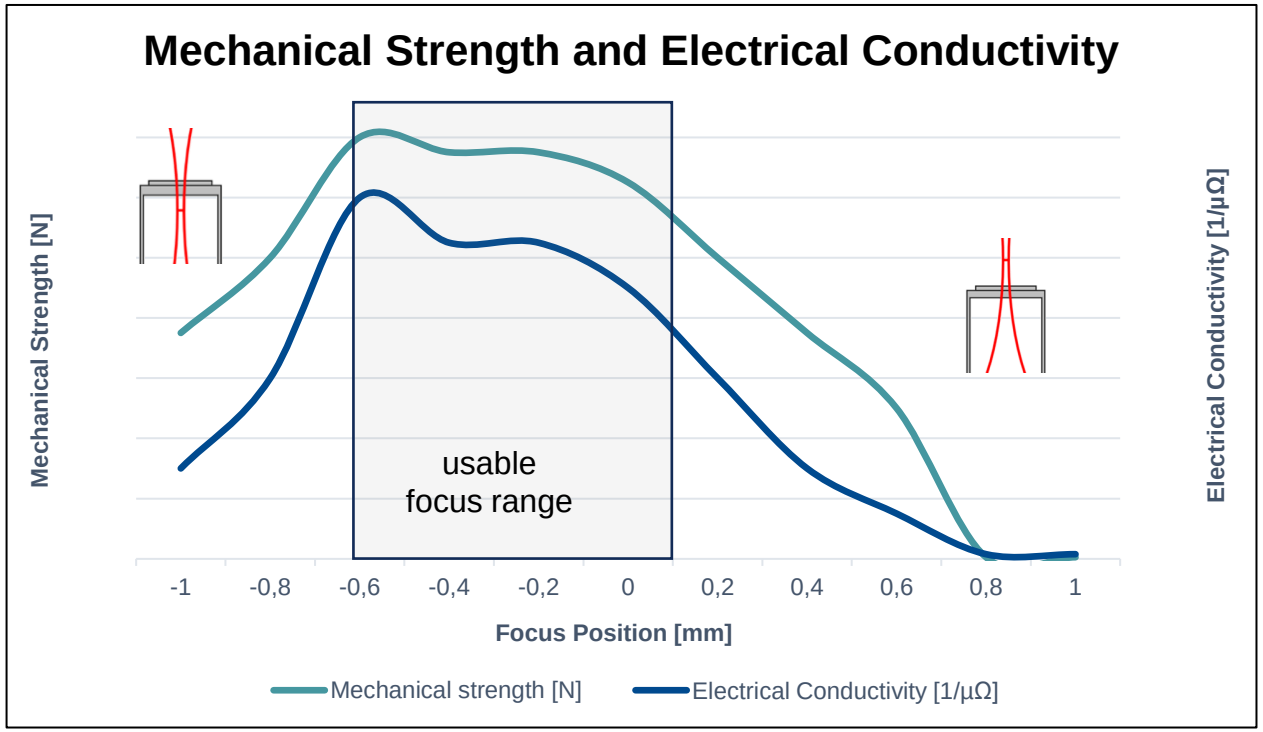


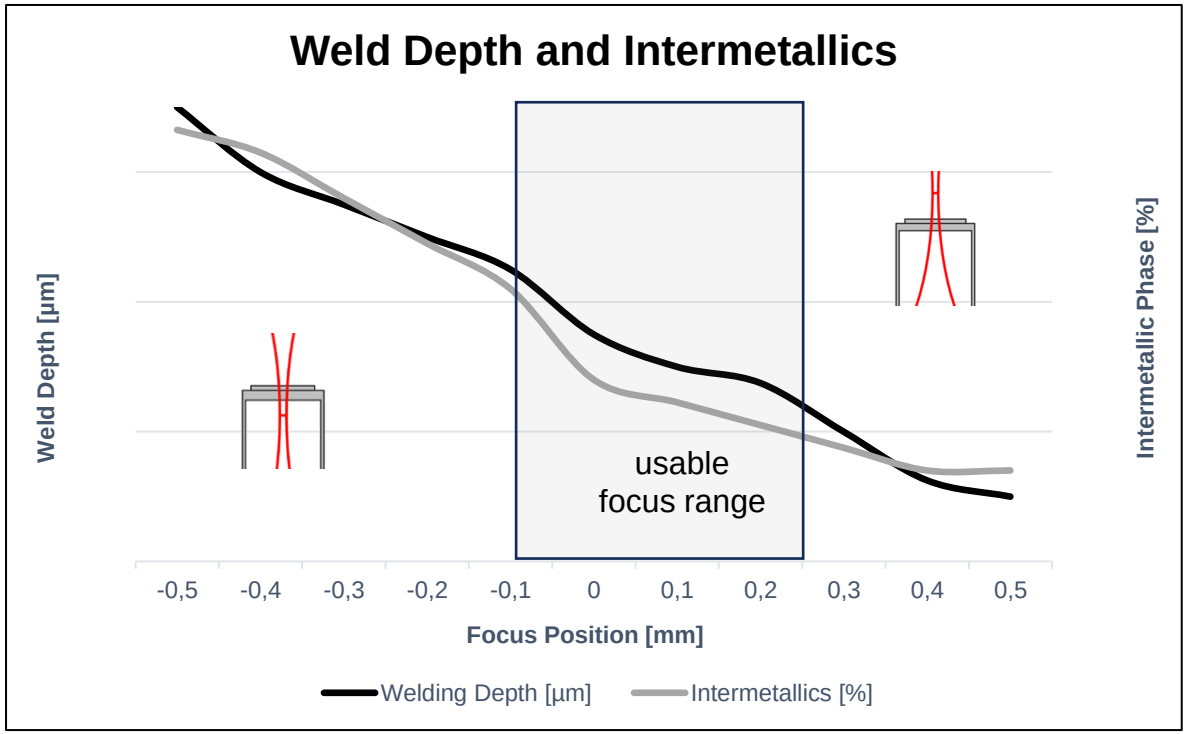
With Precitec AutoFocus (Z)

ADVANTAGES OF AUTOFOCUS FUNCTION

Application Examples

- Focus variation affects welding depth, intermetallic phase, mechanical strength and electrical conductivity

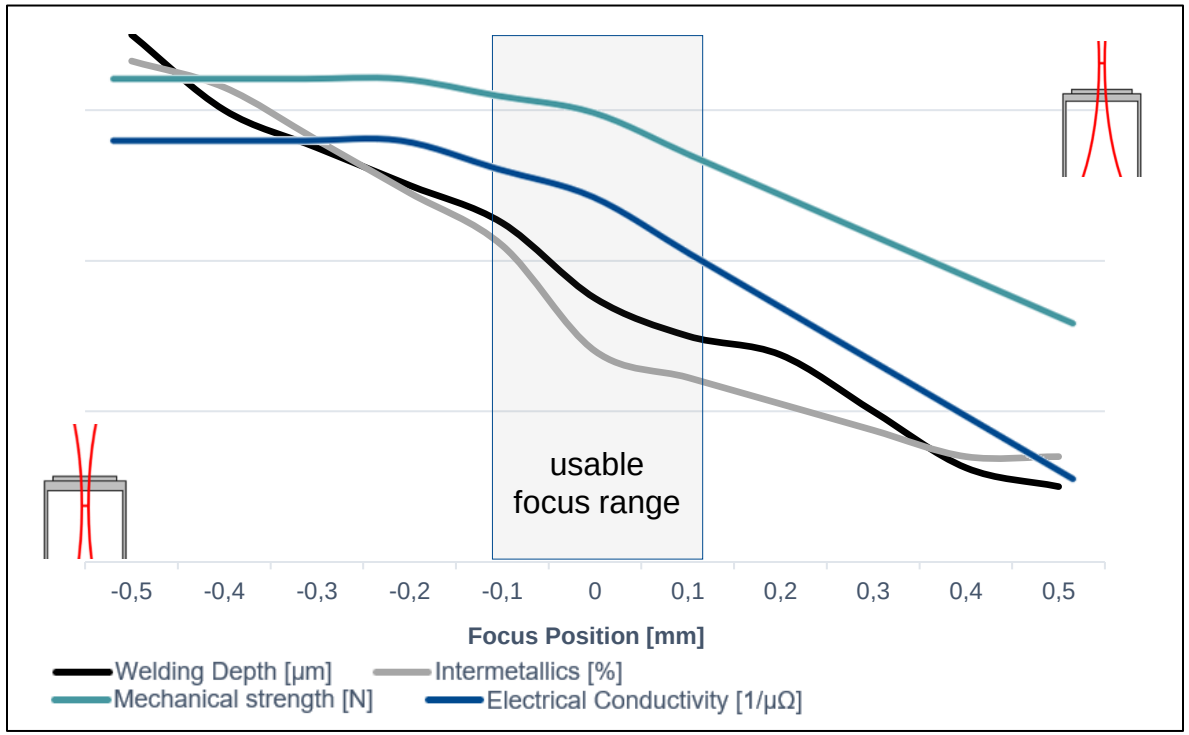




ADVANTAGES OF AUTOFOCUS FUNCTION

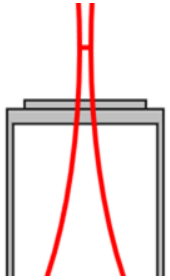
Usable Focus Range

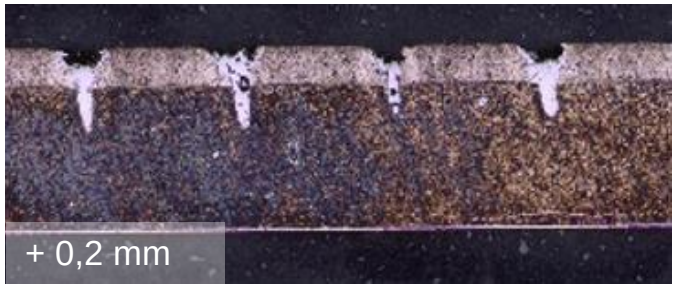
- Compromise between intermetallics, electrical conductivity, mechanical strength and penetration depth

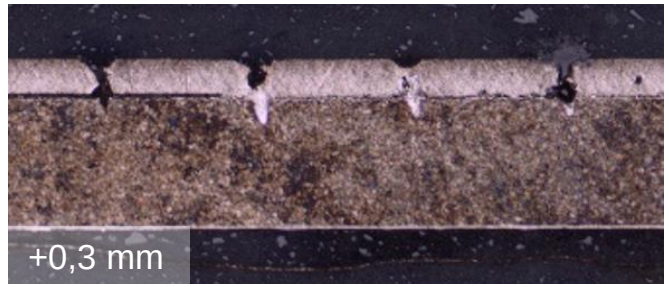


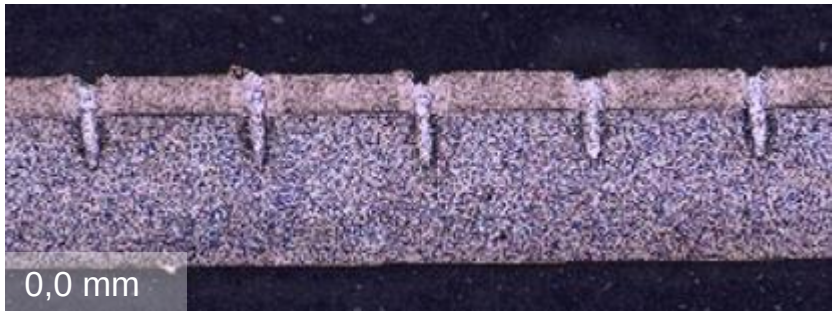
ADVANTAGES OF AUTOFOCUS FUNCTION

Process window for z position ± 100 µm

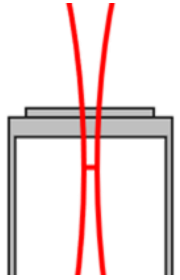


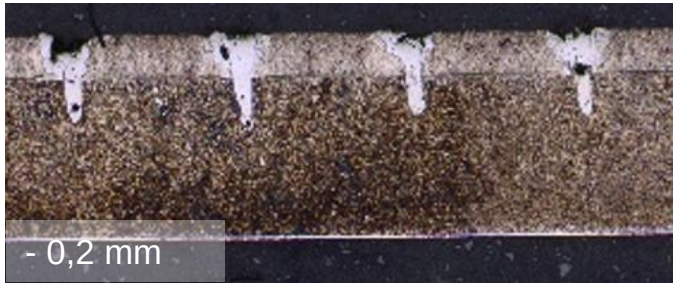


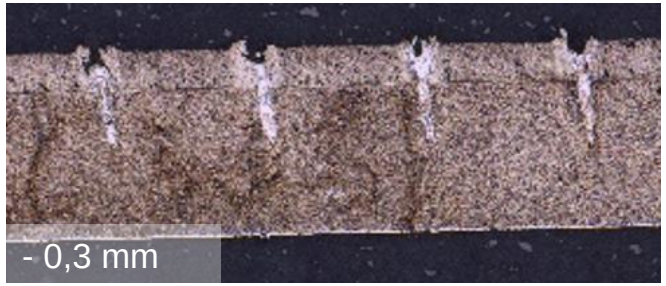


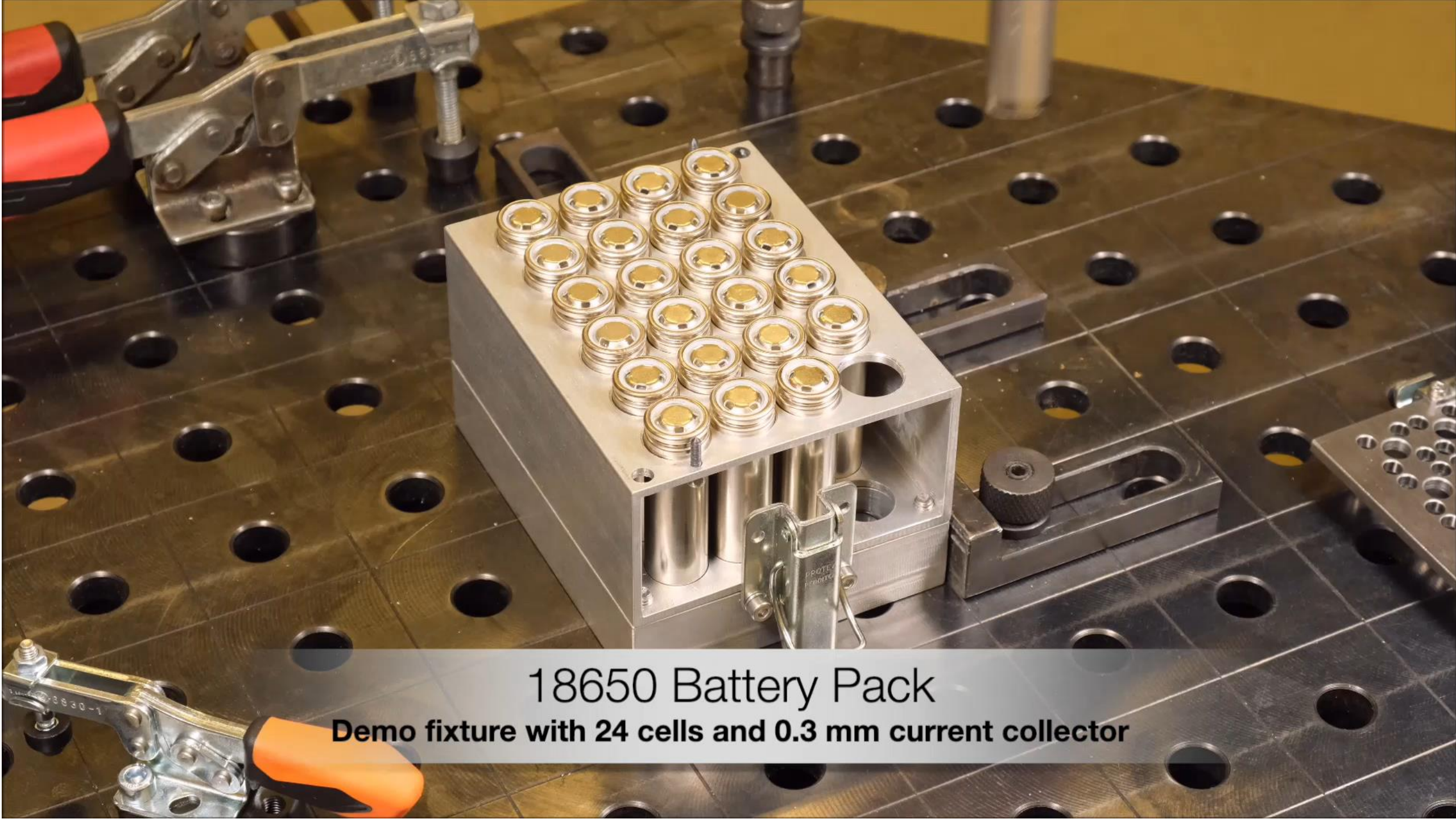


Solution: ScanMaster Autofocus








18650 Battery Pack
Demo fixture with 24 cells and 0.3 mm current collector

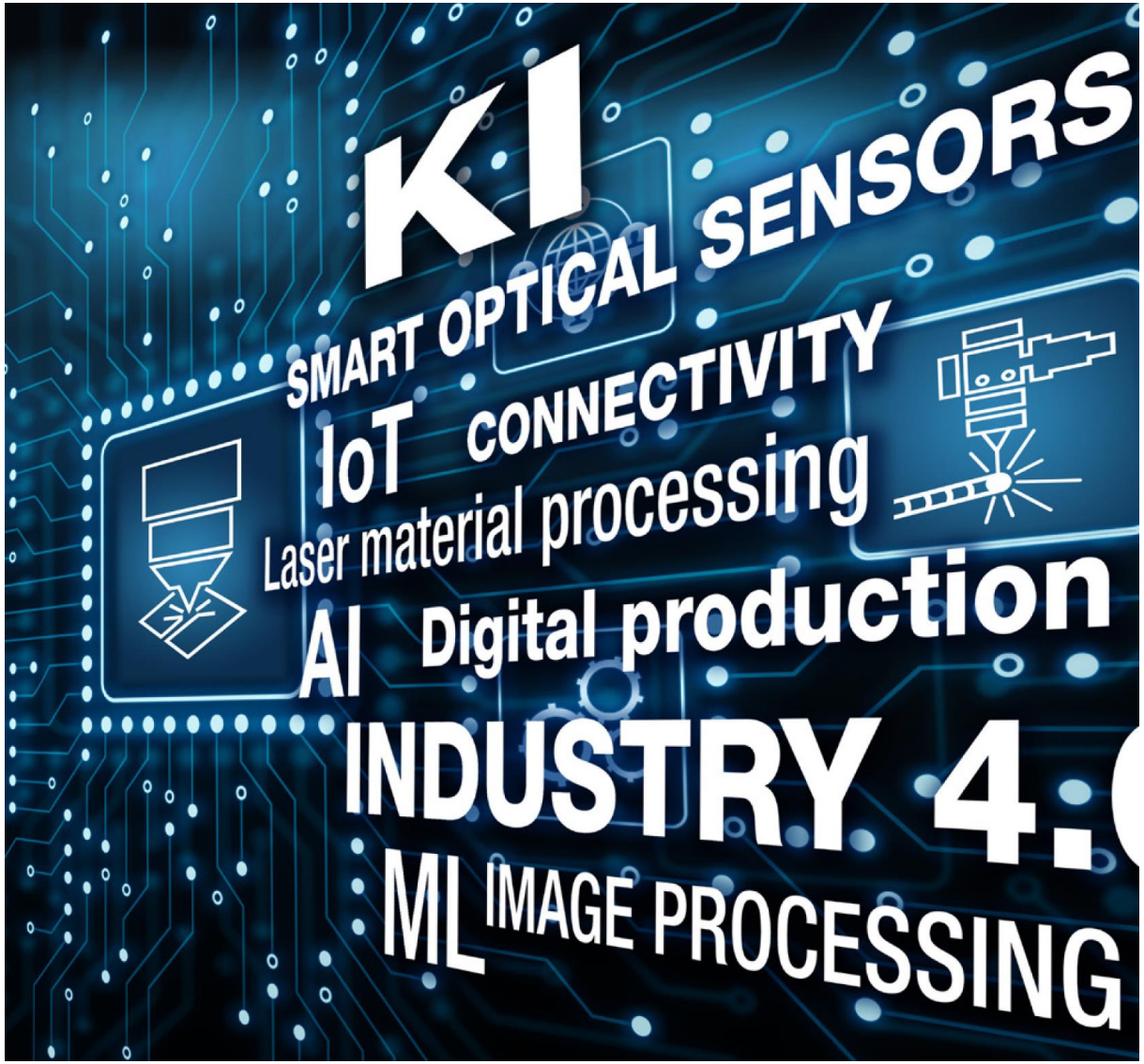
PRECITEC INCUBATOR – GETTING AI ON THE ROAD

Precitec Karlsruhe

In the so-called "incubator" in a startup-like atmosphere, a team now tackles the concepts for the laser process of tomorrow:

- Machine Learning,
- Internet of things (IoT) or
- Artificial intelligence (AI) and
- Cloud Computing

There is already a close cooperation with the higher education institutions in Karlsruhe.



PRECITEC

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