
DILIGINE
德擎光学科技
DILIGINE
PRODUCTS
COLLECTION

The Developing Welding Technology Makes Higher Demands on Detection Technology.

What could go wrong in Welding Process ?

①**Old production lines:** Process instability, low fault tolerance, and difficulty in controlling defect rates during production.

②**Welding quality issues:** Troubleshooting is difficult with unclear direction and long cycles once problems occur.

③**Lack of SPC data support:** Problem resolution requires unplanned downtime, impacting production.

④**New production lines:** Long welding process debugging cycles with unclear direction for quality improvement.

Challenges of Welding Process

Tiny laser spots, Heat effects & High power density → Strong radiation & High noise

Intense laser-material interaction → Wide characteristic spectral signals

High-speed welding processes → Extremely fast monitoring systems

Complex product processes → Non-surface weld quality inspection



About Diligine

Established in 2017, Diligine Photonics is a high-tech enterprise co-founded by a group of overseas returnees Ph.D. graduates, dedicating to the R&D and production of automation testing equipment for laser processing.

Our products cover the entire process from pre-welding control, in-process monitoring to post-welding measurement, and are applied in 3C precision manufacturing, power batteries, 3D printing, automotive parts and other industries to ensure that every step of laser processing is accurate and reliable.

Our business has covered markets such as Thailand, Vietnam, the United Kingdom, France, Hungary, the United States, and Brazil. The company is headquartered in Guangzhou, with wholly-owned subsidiaries in Suzhou and Chengdu.



200+
Employees

50%
R&D team with master's degree

5000m²
R&D and manufacturing base

40+
Authorized patents



100+

Long-term partners across industries

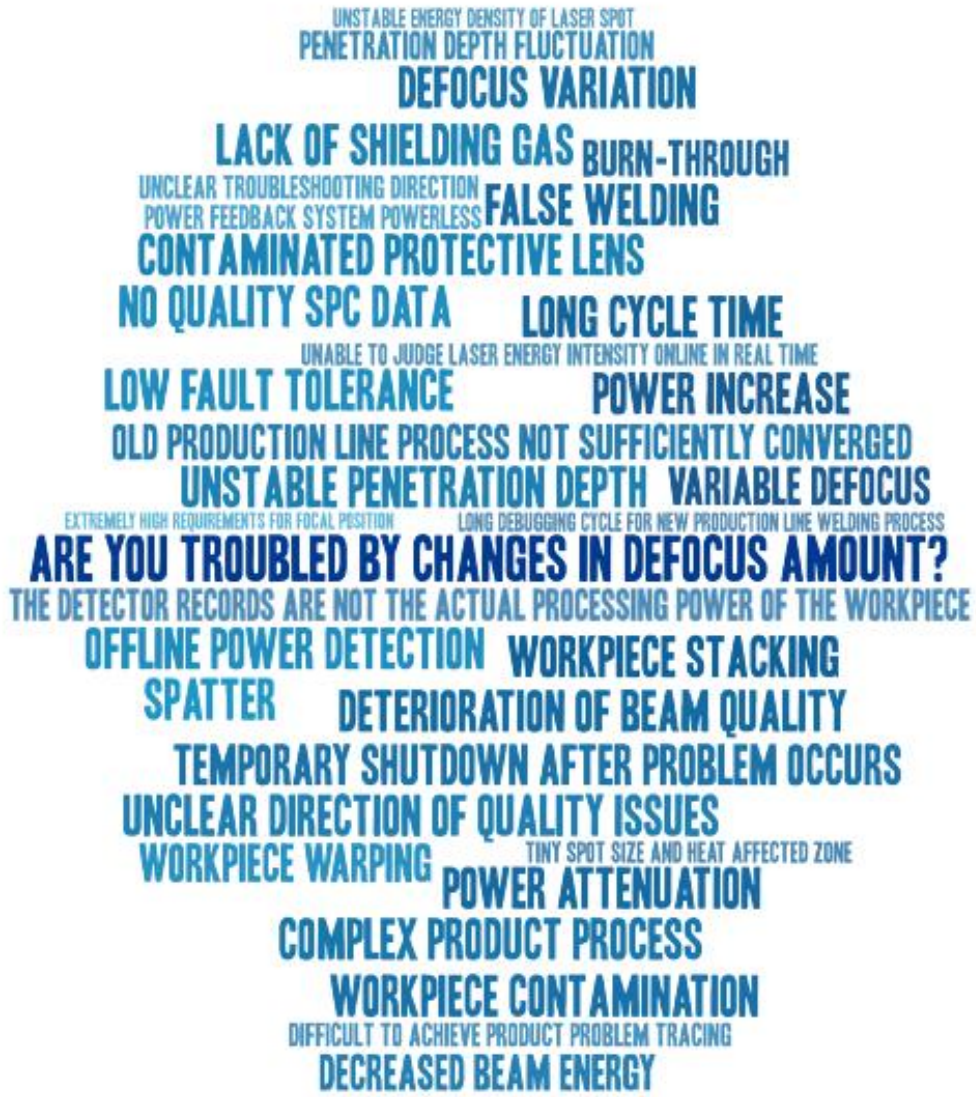
5000+

Diligine equipment in operation worldwide

Pre-Welding

In-Process

Post-Welding

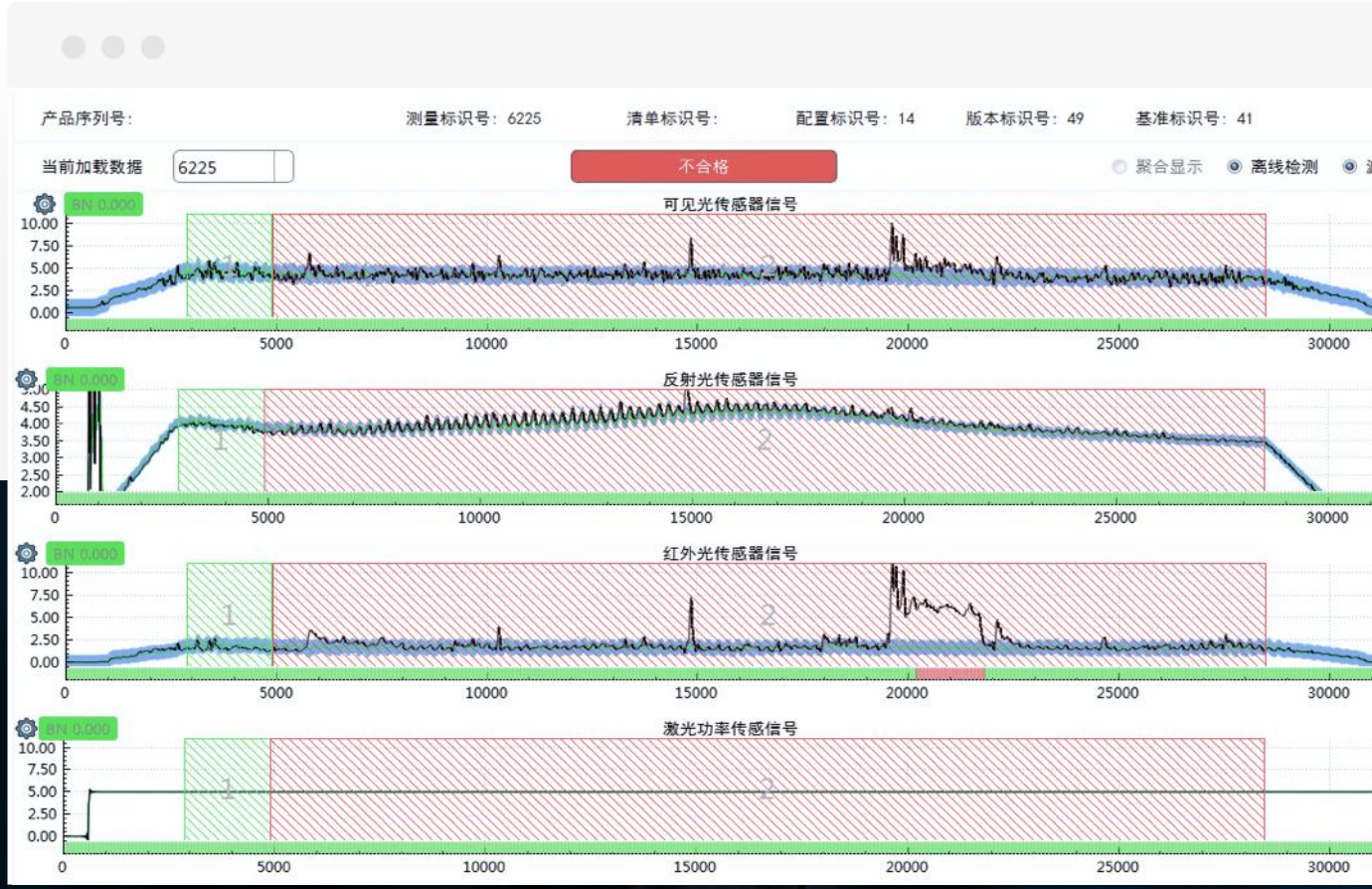


Requires an effective

online monitoring system

Minimal process anomalies may lead to significant quality defects in laser welding.

Laser welding properties enables real-time monitoring.



Optical signals, such as metal vapor, laser reflection, and molten pool thermal radiation, generated during laser welding reflect the welding status and potential defects.

The Diligine WDD system converts these optical signals into electrical signals via photodetectors, analyses them to detect welding defects, and ensures quality control.

Comprehensive High-Precision Laser Welding Quality Assurance Solution

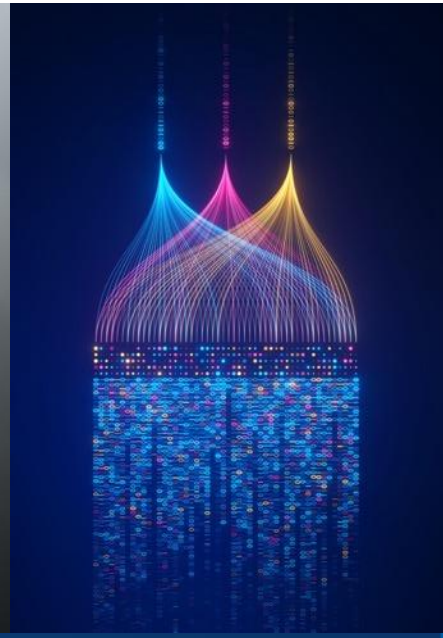












LFS
Laser Focus Sensor

WDD
Welding Defect Detection

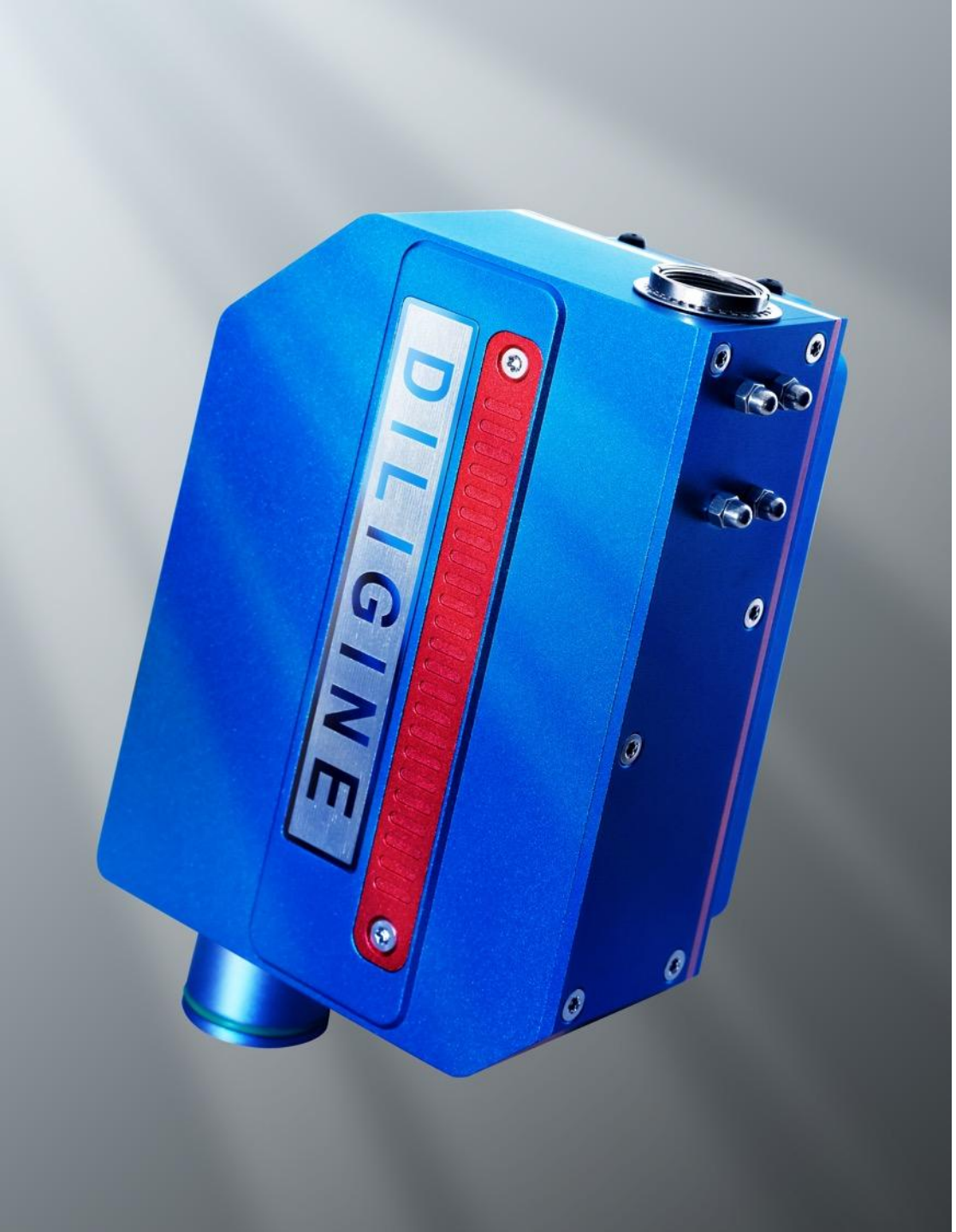
LPM
Laser power Monitor

WDM
Welding Depth Measurement

OTS
Optical Tomography Scan

AI+
AI Overkill Reduction

Pre-Weld Control | **In-Process Monitor** | **Post-Weld Measurement** | **AI Fusion Inspection**



ALPAS-WDD

Advanced Laser Process Assessment System

Welding Defect Detection

Real-Time Monitoring

Real-time detection
with instant feedback
User-friendly HMI
Up to 200kHz sampling rate

Non-destructive measurement

Coaxial measurement
Less optical path calibration
Stable process standards

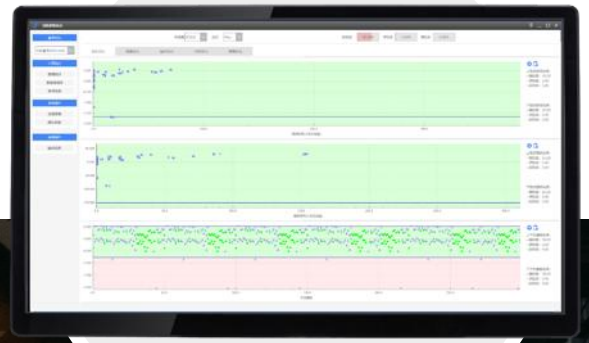
High compatibility

Adapts to mainstream laser device
Standalone or built-in deployment
for diverse scenarios

Three Modules of WDD ensure Higher Precision in Detection



Multi-Spectral Detection Module



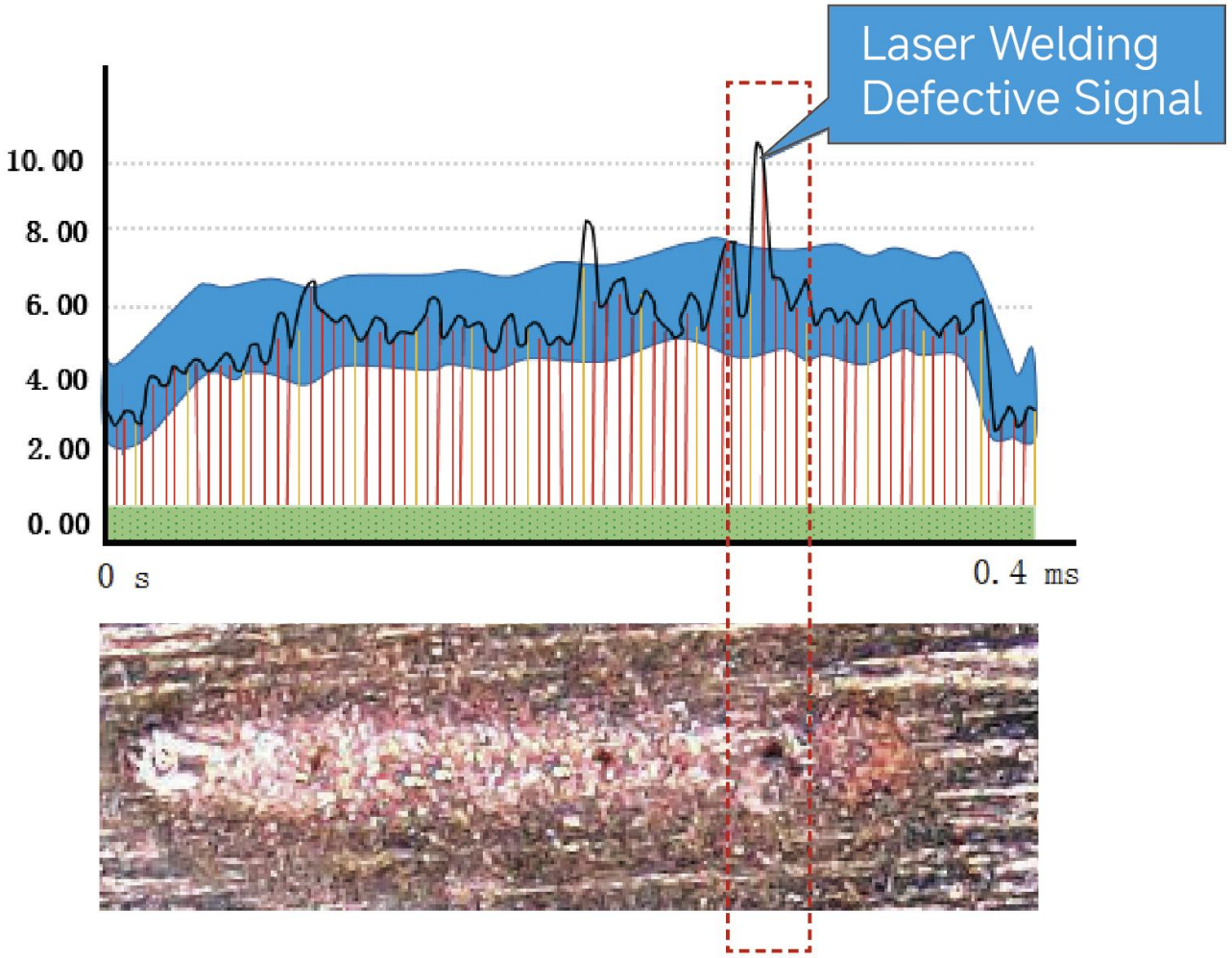
Laser Welding Detection & Analysis Software

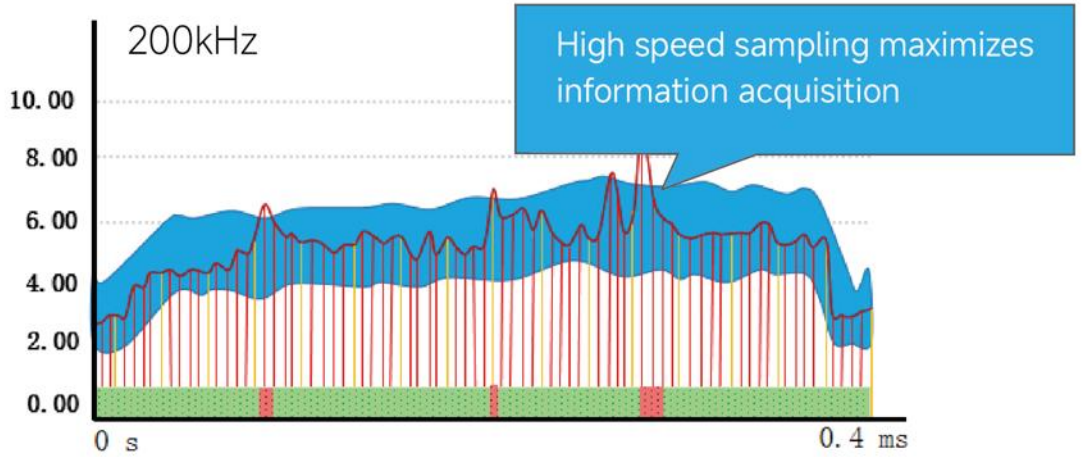


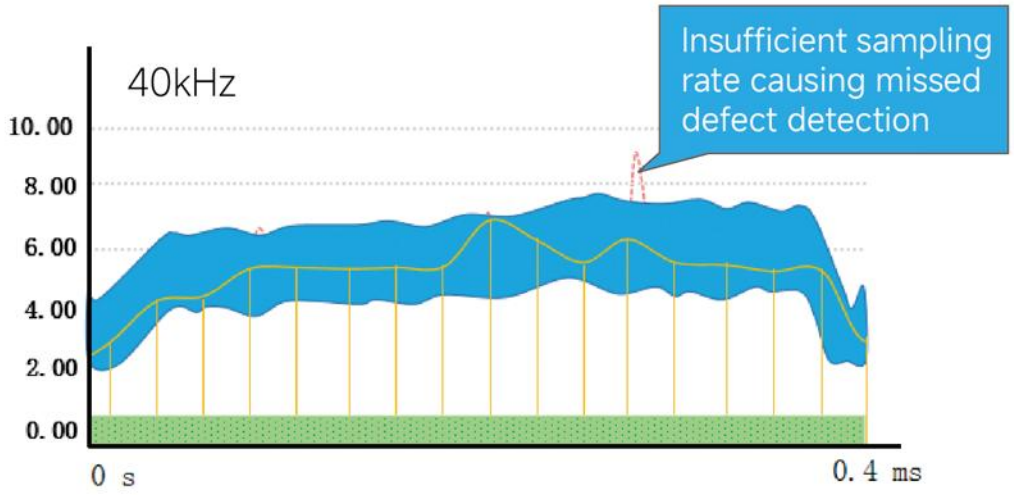
Programmable Control Module

Ultra-High-Speed Sampling: No defect signal is missed

The new WDD sensors achieve up to 200kHz sampling, capturing finer details of the welding process.







Seamless Compatibility

WDD sensors are adaptable to major laser brands, welding heads, and laser types globally



Scanning laser heads



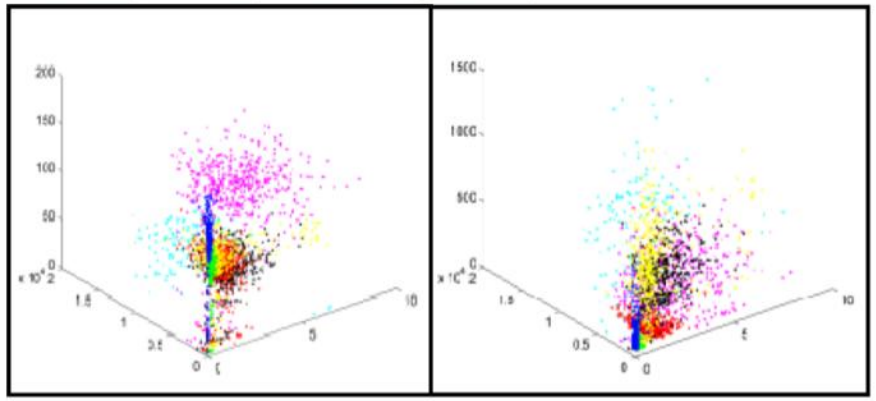
Oscillating laser heads

Fixed-focus laser heads

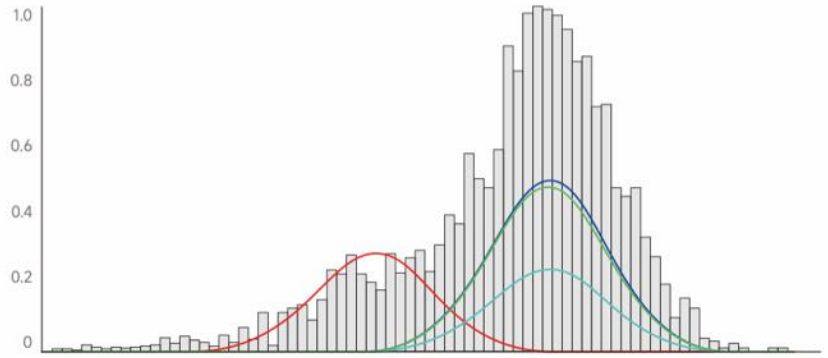
1. Using data to stabilize process standards

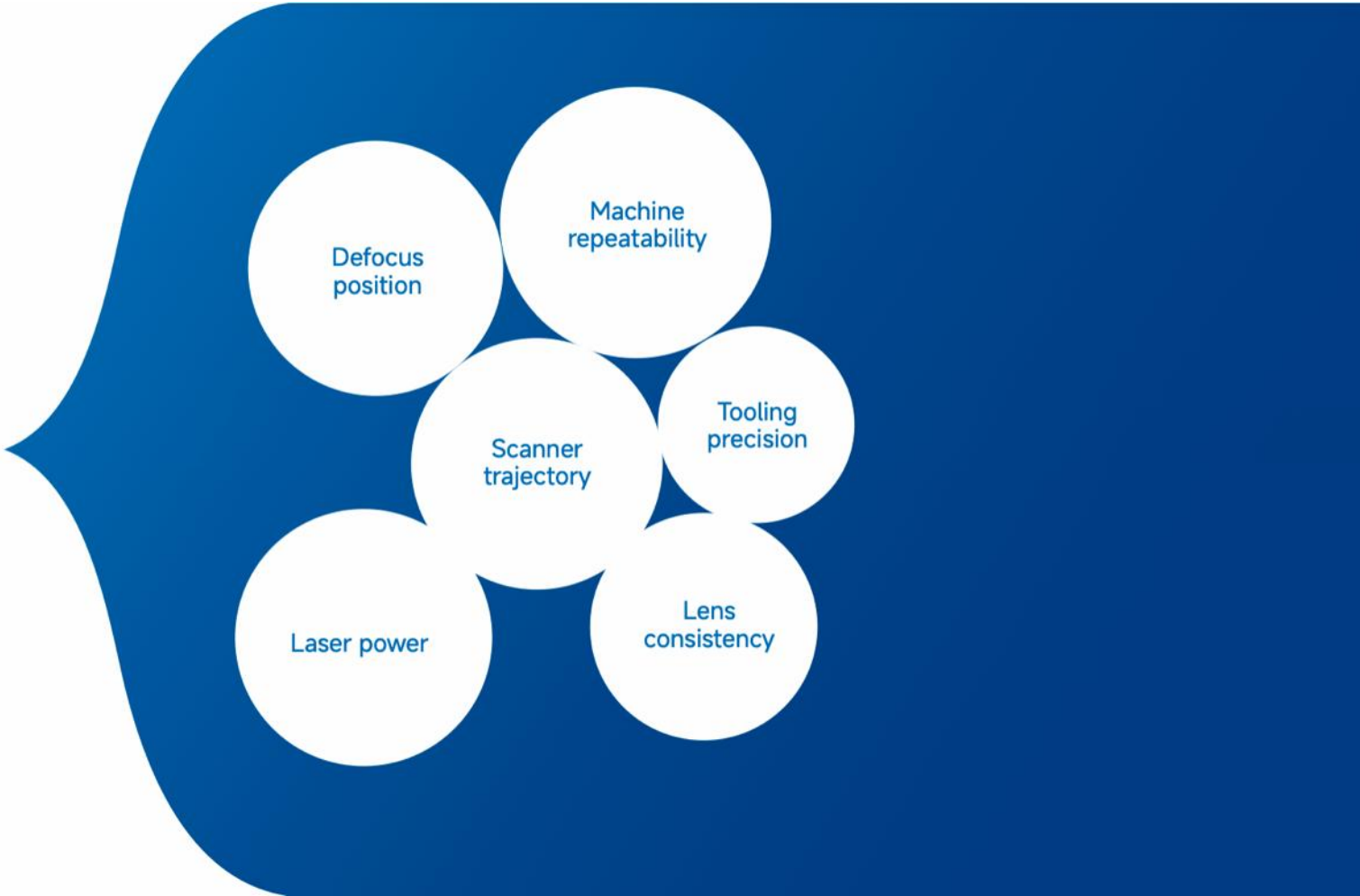
When introducing new equipment, parameter fine-tuning is required for each production line. WDD can collect data to determine process confirmation standards, ensuring consistency.

Distribution patterns of positive and negative samples



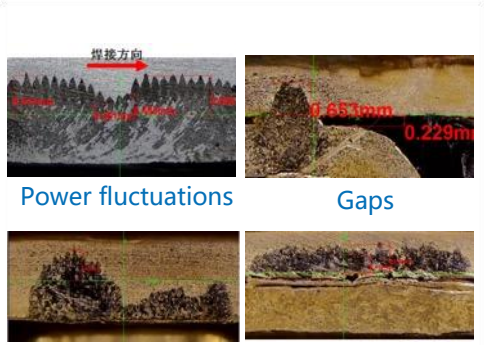
Evaluation Criteria for Welding Processes

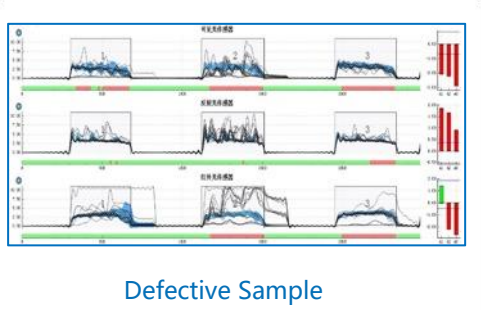


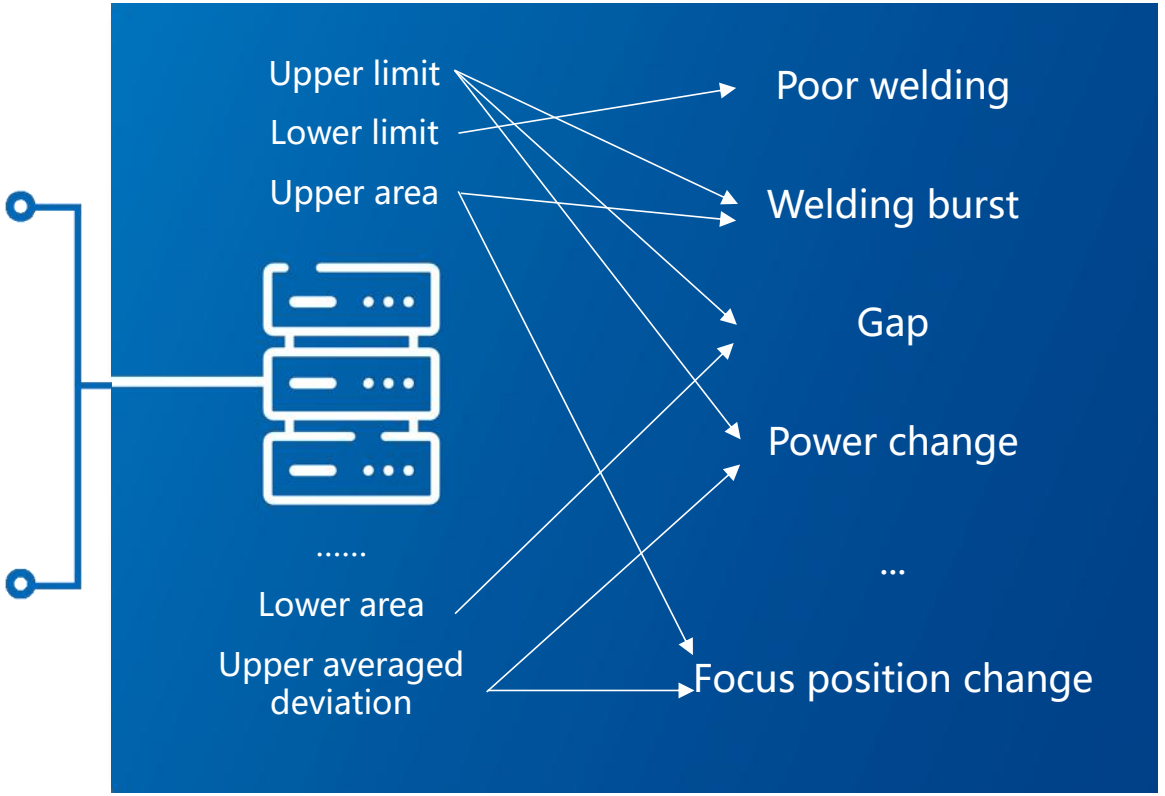


2. Real-time monitoring of welding quality

Early warnings of welding defects & process monitoring and data analysis to support decisions that enhance production quality.





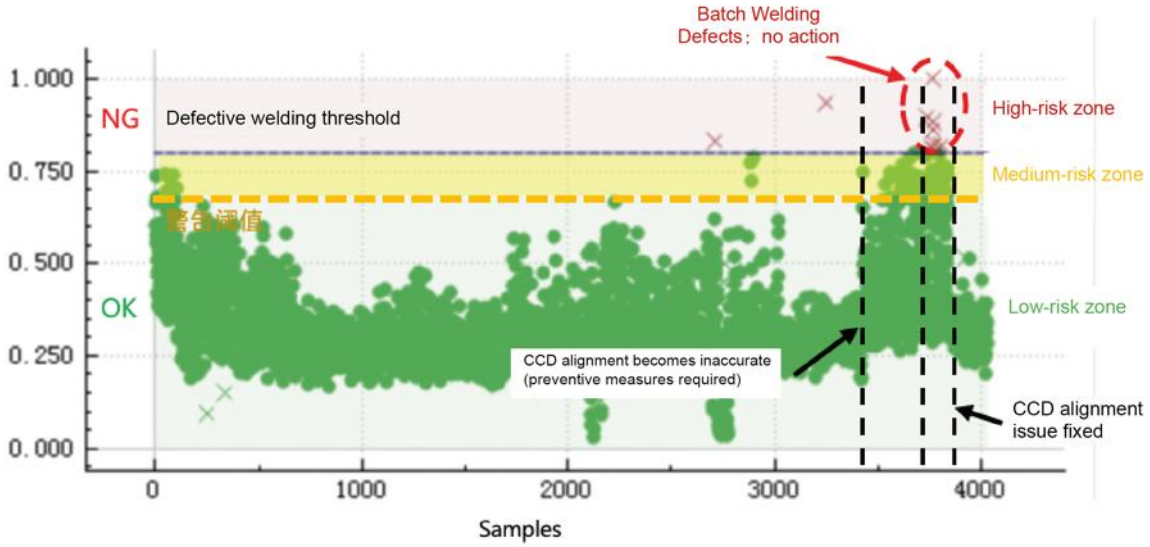




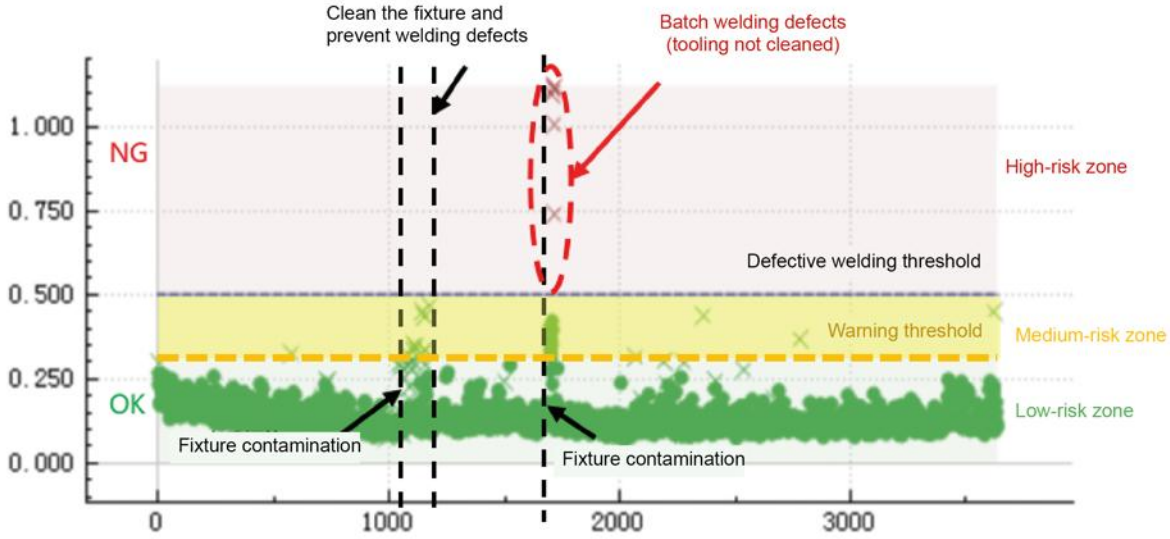
- Feature extraction
- Defect model (expert algorithm)
- Quickly identify abnormal factors

3. Proactive defect prevention for seamless production

Quickly identify defect categories, reducing the time and cost of problem diagnosis.



● Case 1: Process monitoring detects CCD alignment issues.

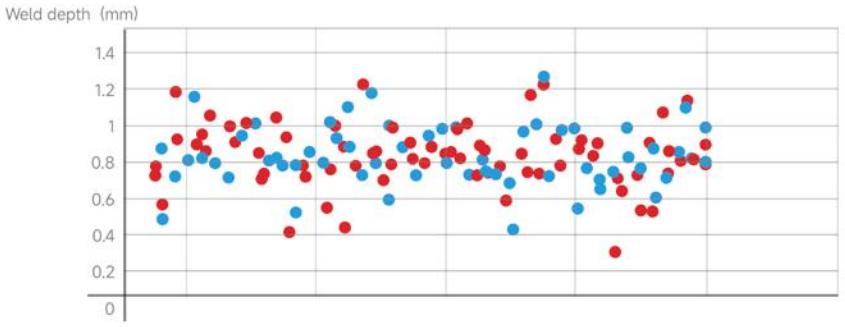


● Case 2: Process monitoring detects jig contamination.

4. Determine the convergent

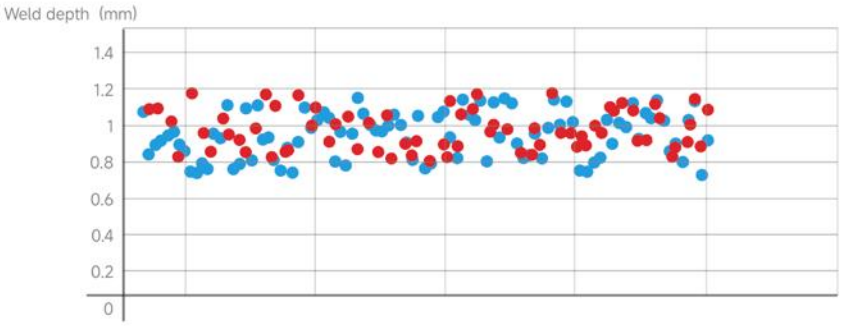
WDD can help to determine stable and convergent welding parameters to enhance welding stability (CPK) and increase process tolerance.

BEFORE

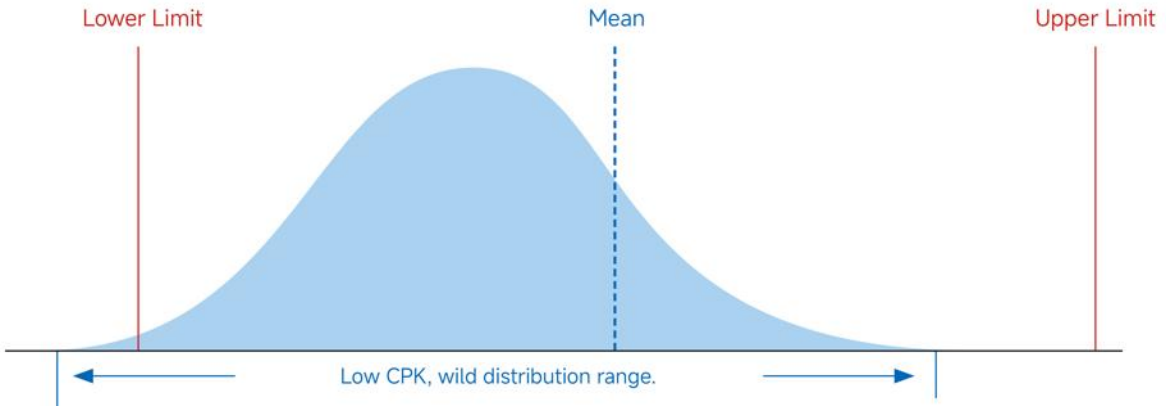


CPK=1.71

AFTER



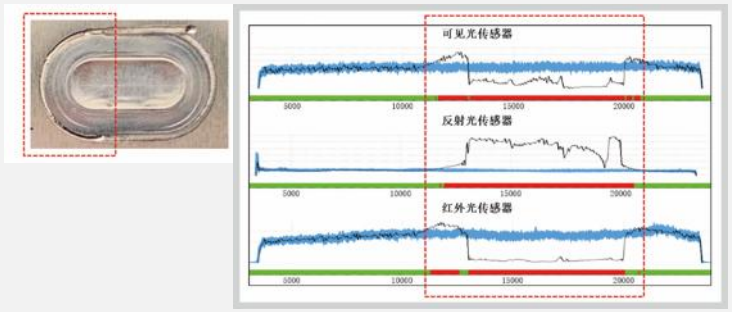
CPK=2.01



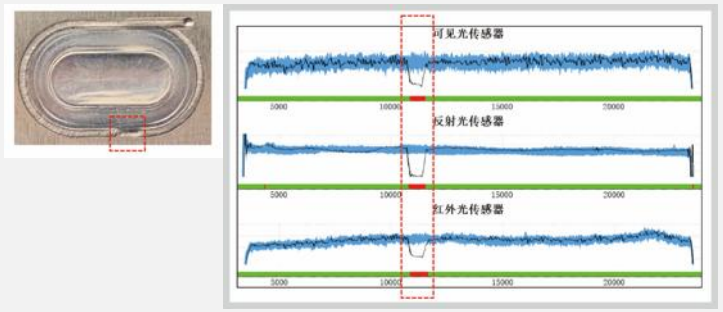
When quality boundaries are narrow, the process becomes less tolerant to equipment anomalies. Minor deviations in operating conditions or equipment can result in defects.

Explosion-Proof Valve Welding Defect Detection

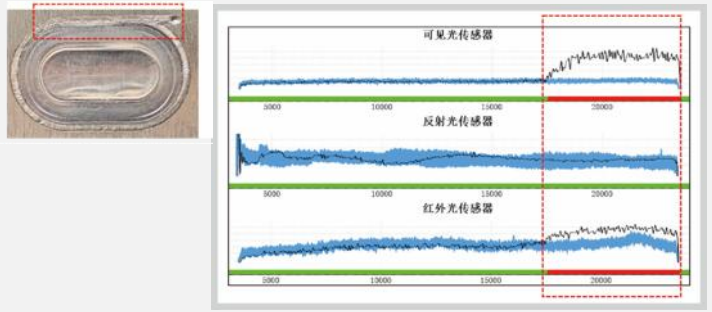
Defocusing variation



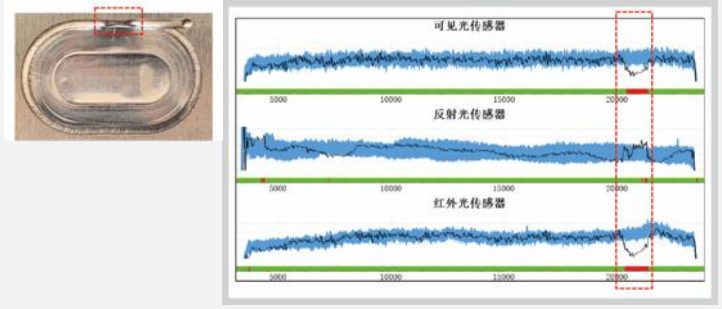
Laser power reduction



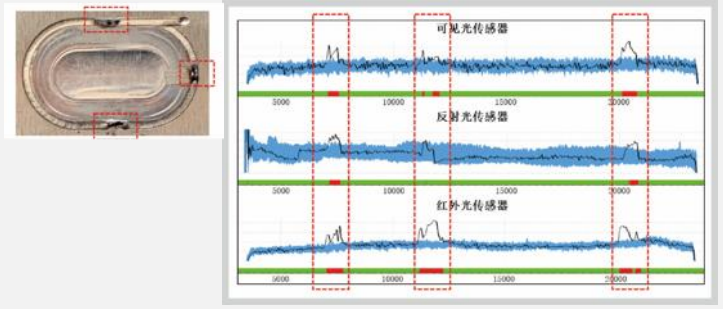
Insufficient shielding gas



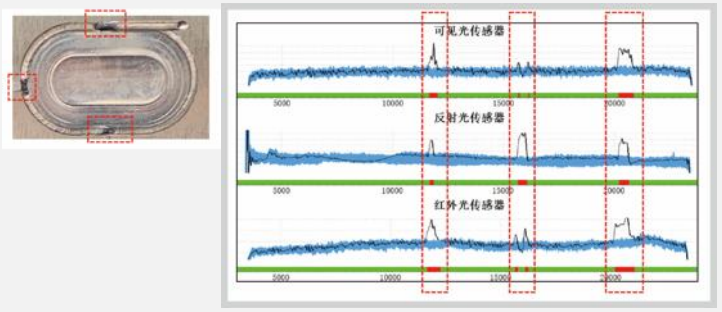
Deformation



Inter-layer contamination

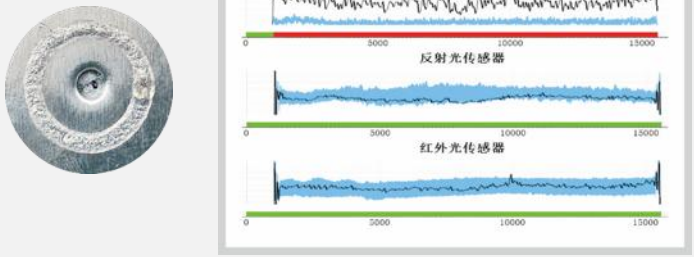


Surface contamination

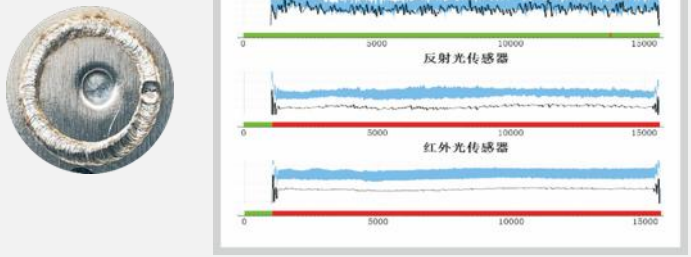


BUSBAR Welding Defect Detection

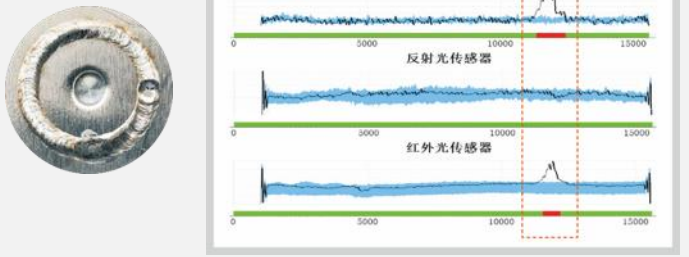
Insufficient shielding gas



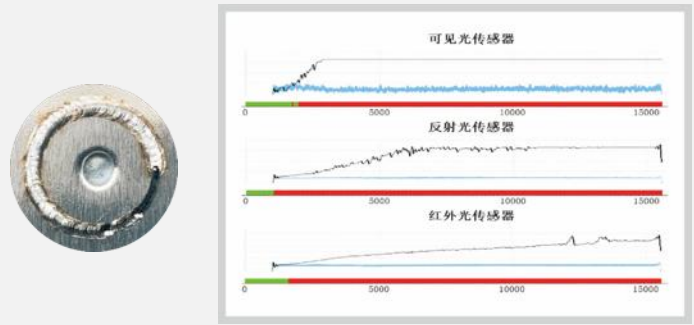
Laser power reduction



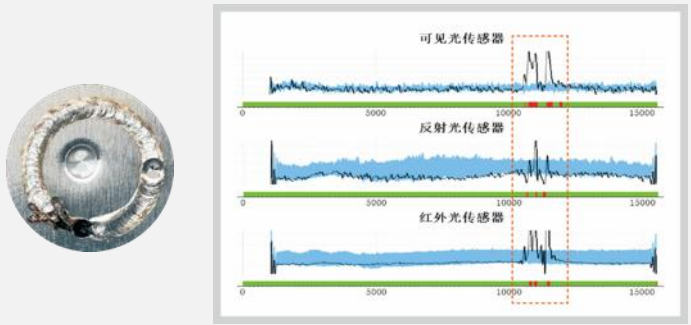
Surface contamination



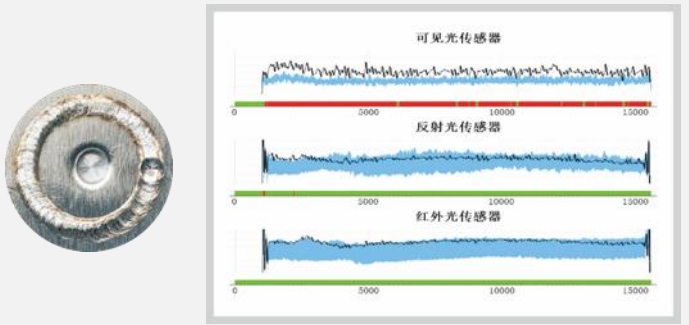
Protective window contamination



Inter-layer contamination

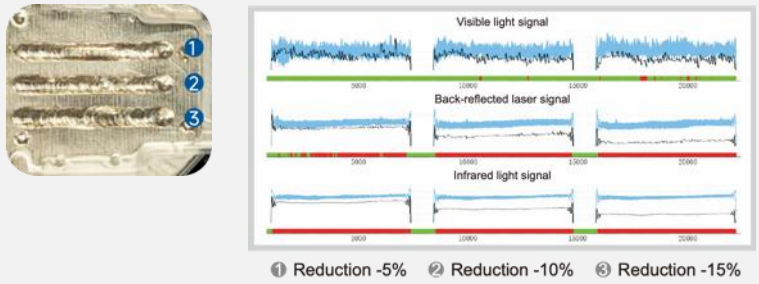


Defocusing variation

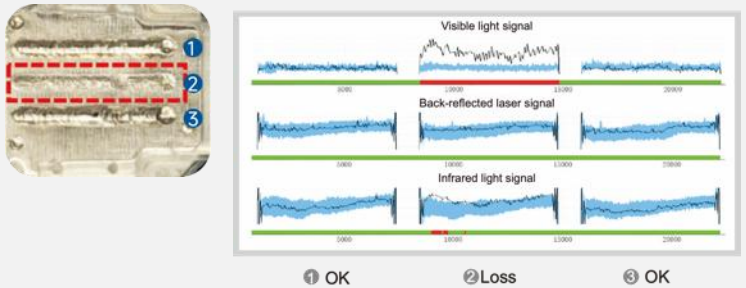


Connector Tabs Weld Defect Detection

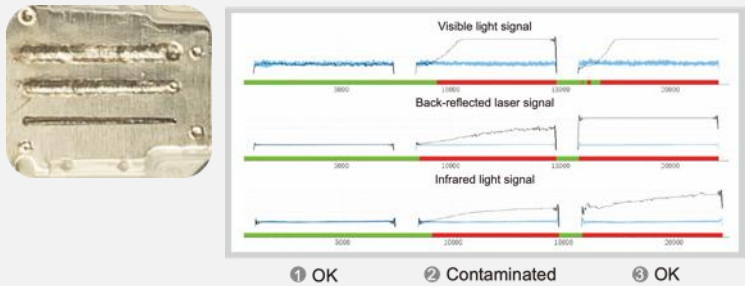
Laser power reduction



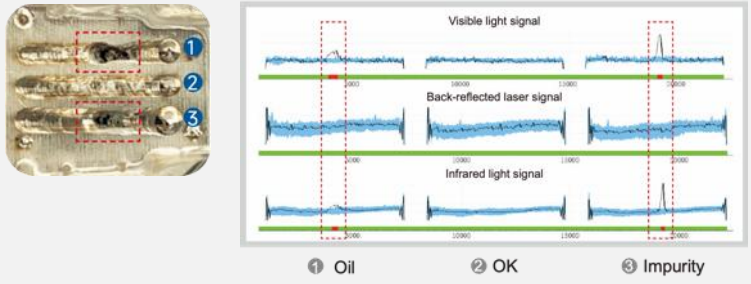
Insufficient shielding gas



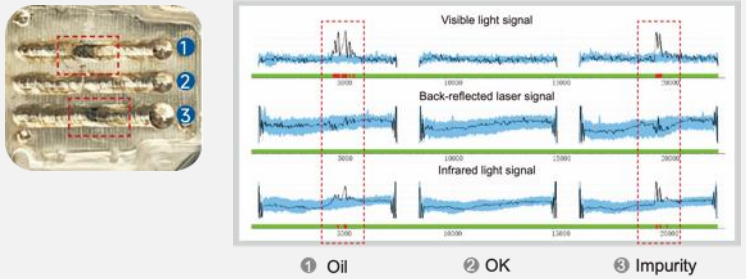
Protective window contamination



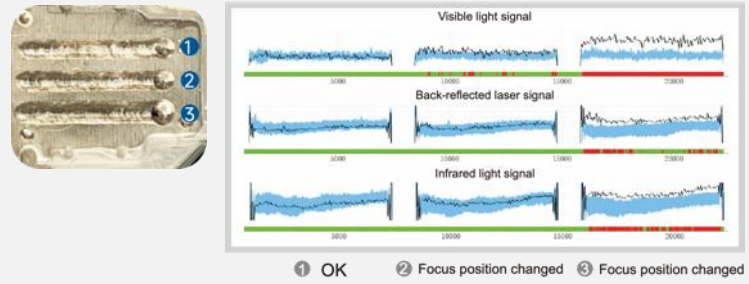
Surface contamination



Inter-layer contamination

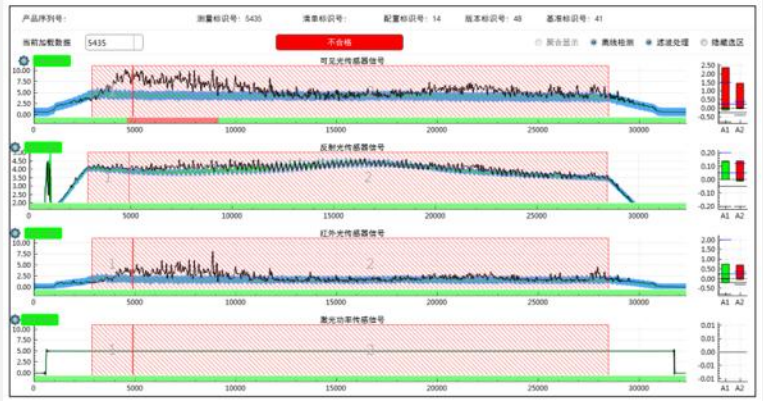


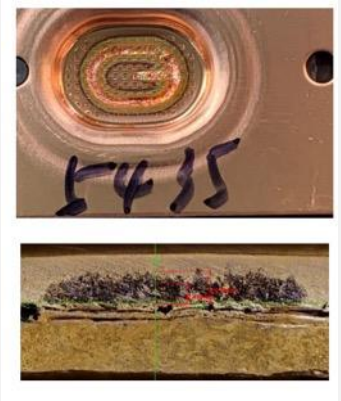
Defocusing variation



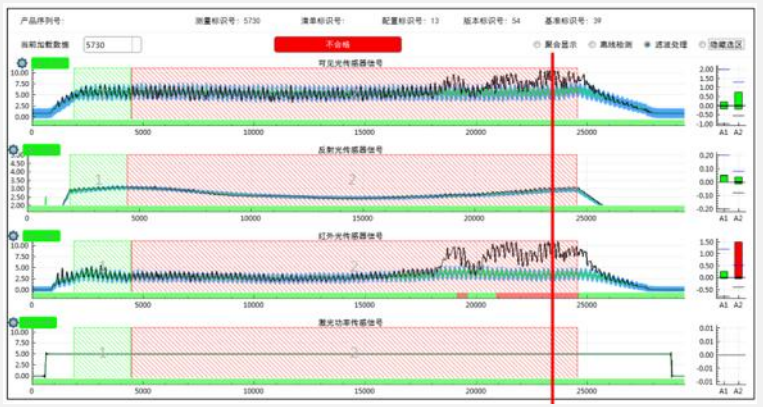
WDD Application in Automotive Industry: Power Batteries

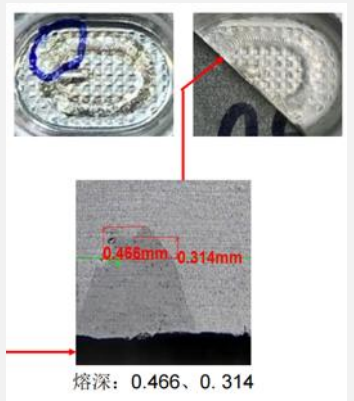
Surface Dent



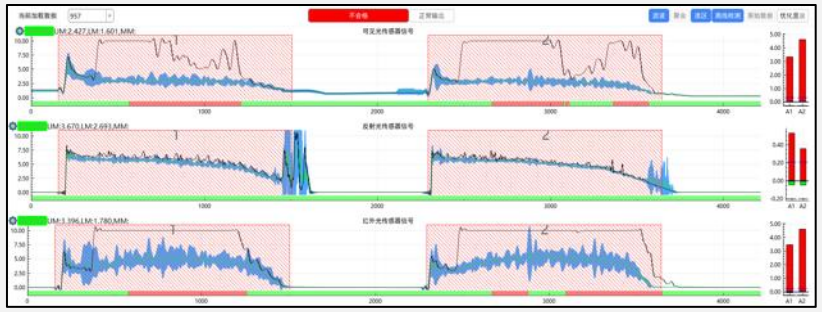


Abnormal Weld Penetration





Welding Burst
-Interlayer Grease Contamination



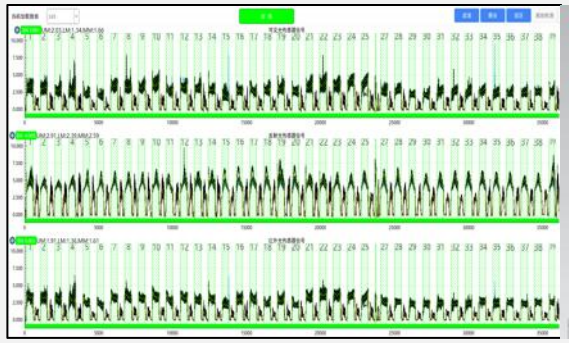
Upper Material Layer

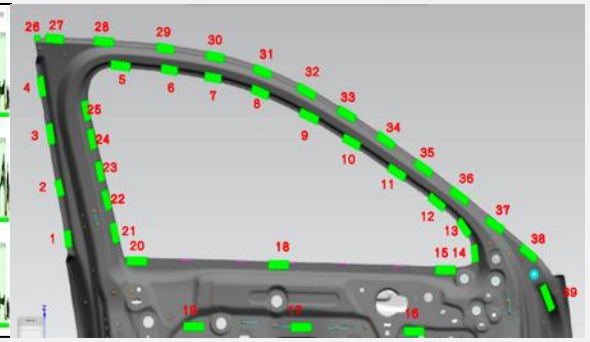


Lower Material Layer



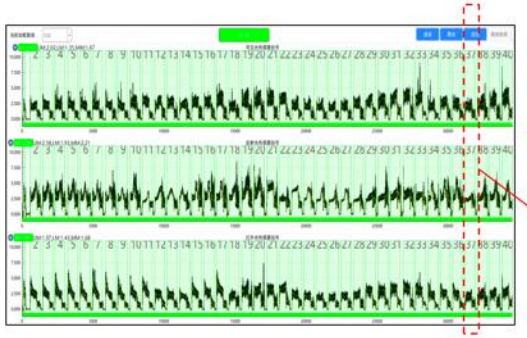
Left Front Door Weld Spot

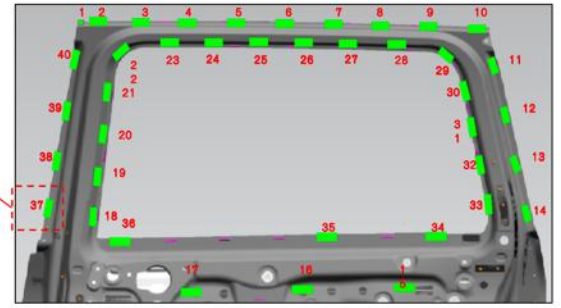




WDD Application in Automotive Industry: Motor and door

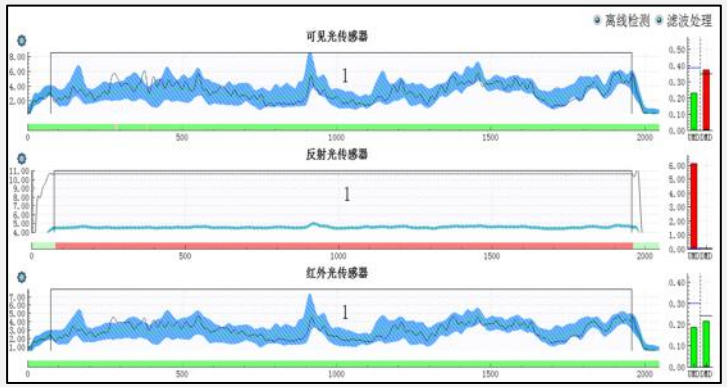
Right Front Door Weld Spot





Seat Slide Rail

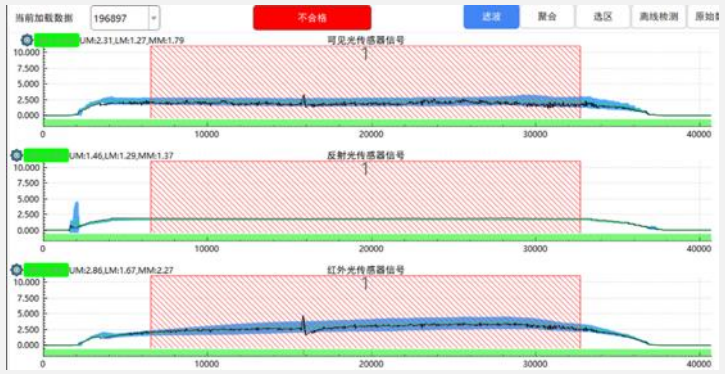
- Protective Lens Contamination





Solenoid Valve

- Partial poor welding

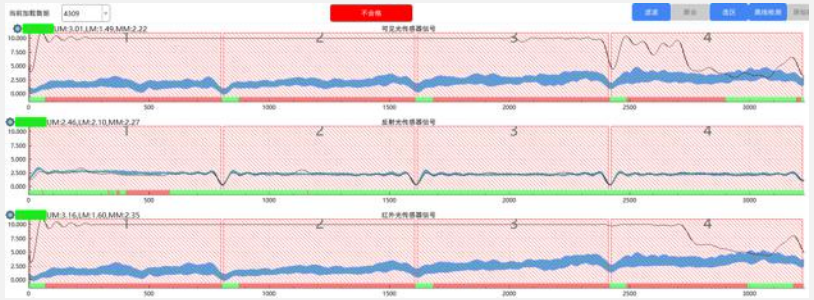






Hairpin Motor

- Surface Contamination



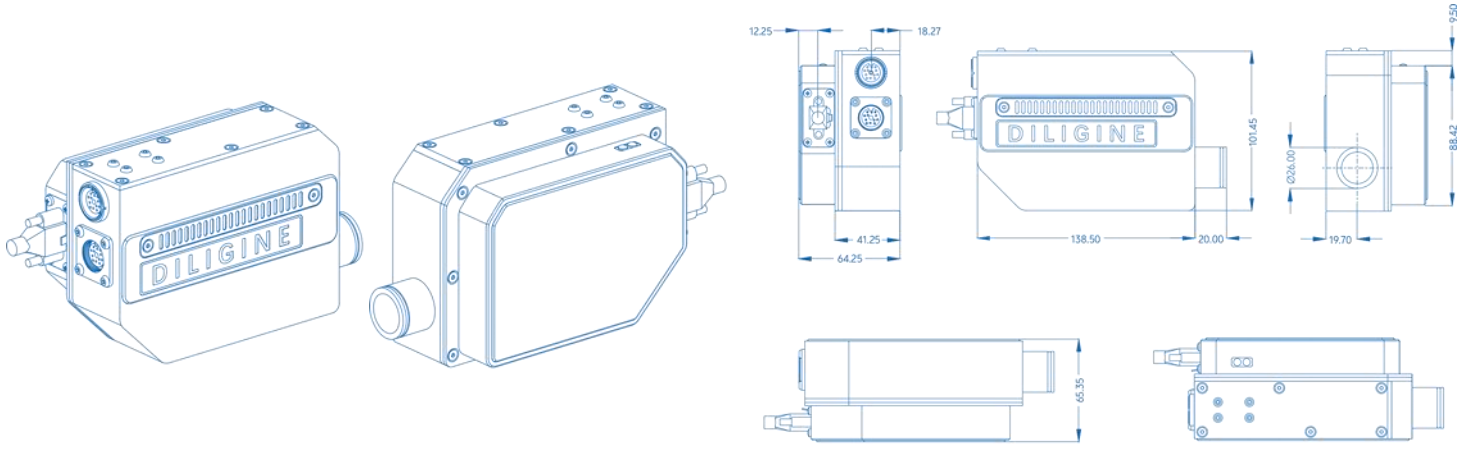






WDD
Welding Defect Detection

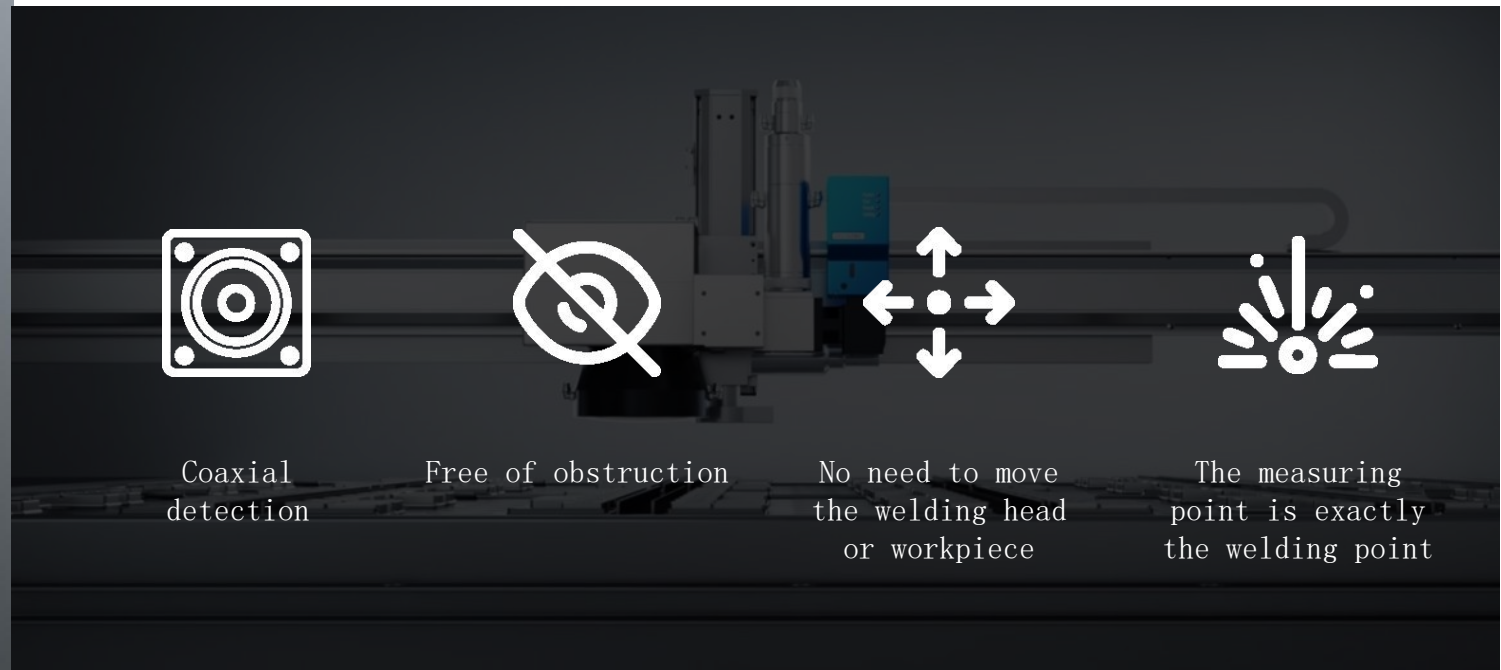
Applicable Laser Power	20W-20kW
Induced Spectral Range	400nm-1800nm
Sensor Signal Types	Visible light, Back-reflected light, Infrared light, Laser power
Sensor Types	CCD,Spectrometer
Compatible Laser Sources	Fiber, Disk, Diode, YAG, MOPA, Blue laser
Compatible Laser Heads	Fixed-focus laser heads, Oscillating laser heads, Scanning laser heads
Protection Level	IP65
Collection Frequency	1kHz-1MHz
Communication Protocol	TCP/IP
Interface Type	1000M Network
Power Supply	±15V
Identifiable Defects	Weak weld, Burn-through, Spatter explosion, Laser energy anomaly, Surface contamination, Shielding gas anomaly, Defocusing deviation
Operating Temperature	+5°C to +55°C
Relative Humidity	⩽90%
Weight	Approx. 2.4 kg (including optical path calibration module)





LFS
Laser Focus Sensor

LFS is a micron-level coaxial focus measurement instrument launched by Diligine. It features high measurement accuracy, a long measurement range, and real-time feedback, providing an effective solution for workstations with high requirements for welding focus stability.



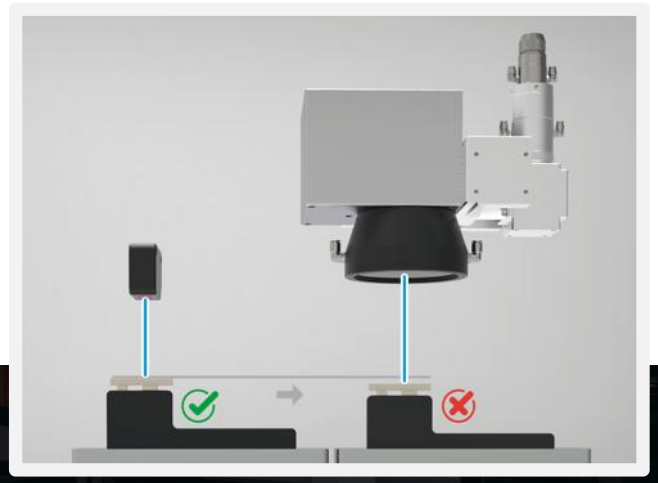
Coaxial detection

Free of obstruction

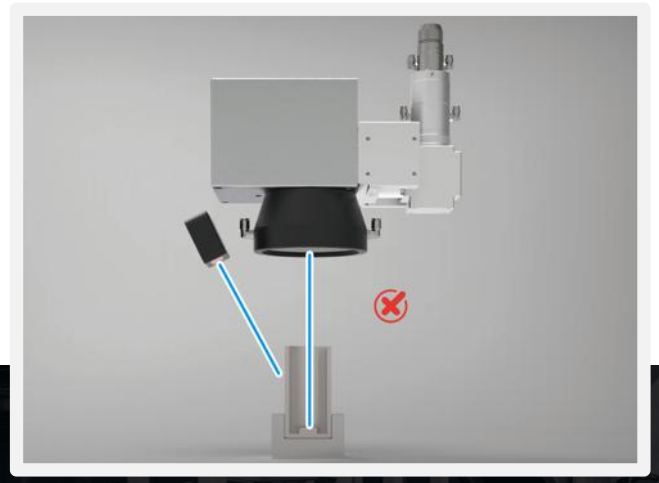
No need to move the welding head or workpiece

The measuring point is exactly the welding point

Traditional Measurement

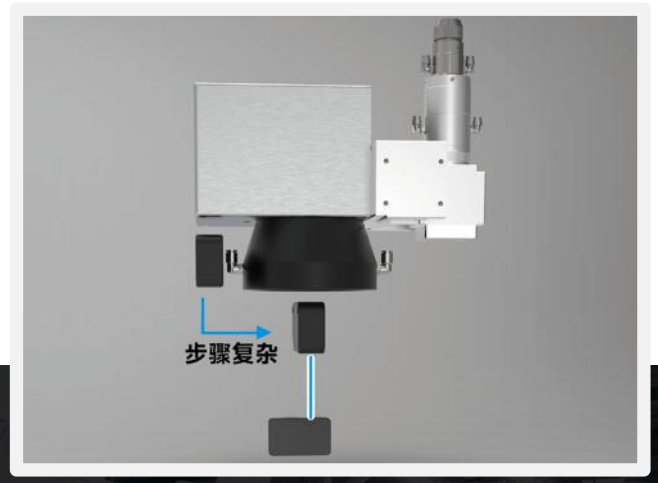


The measuring position is not aligned with welding position. Unable to determine the laser head's height, possibly causing defocused and weak welding.



Possible obstruction of the measurement beam, leading to inaccurate measurement values.

Poor flexibility—when the product has multiple pads, a single off-/axis measurement device can only measure one pad.



Complex process, resulting in long measurement times and reducing production efficiency.

Errors from repeated movements of the measurement mechanism will accumulate, increasing the overall measurement error.

Real-Time Data Feedback

The LFS provides real-time values for focus deviation, allowing for timely corrections to prevent welding quality issues. It can also integrate with the APLAS-WDD to comprehensively ensure product quality and process stability.



Online High-Precision Measurement

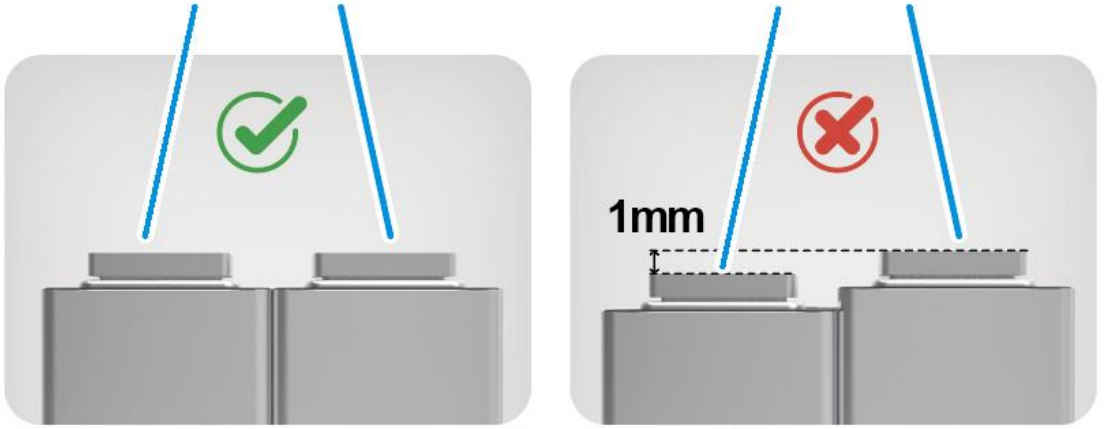
Online High-Precision Measurement < 0.1s

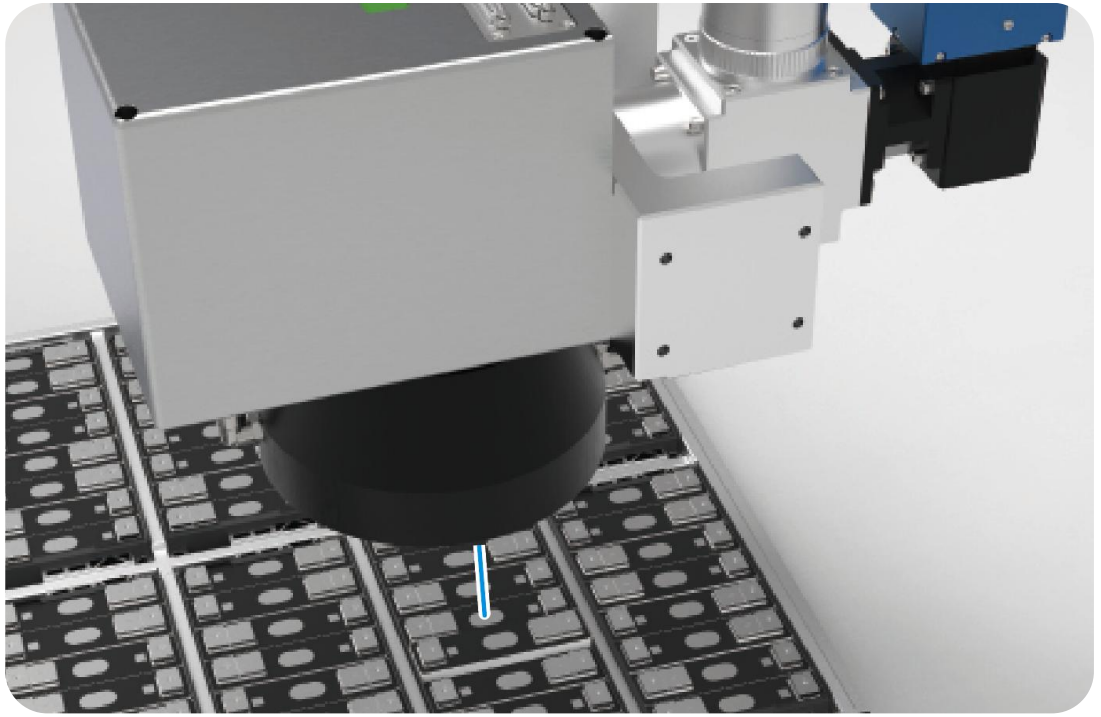
Maximum Measurement Accuracy 50μm

Extended Measurement Range 10mm

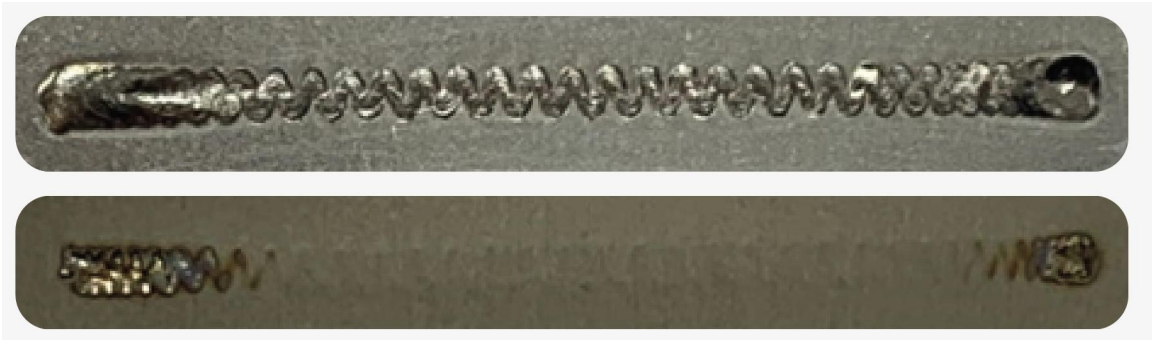
BUSBAR Welding

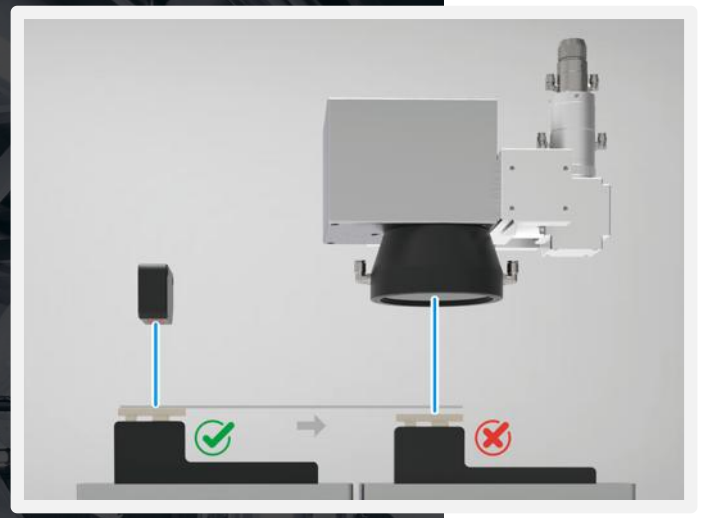
Measuring the height position at two specified points to detect the height difference between them. Allowing for simultaneous measurement of the overall height variation of the target object, achieving stable and rapid detection.





Welded products on site



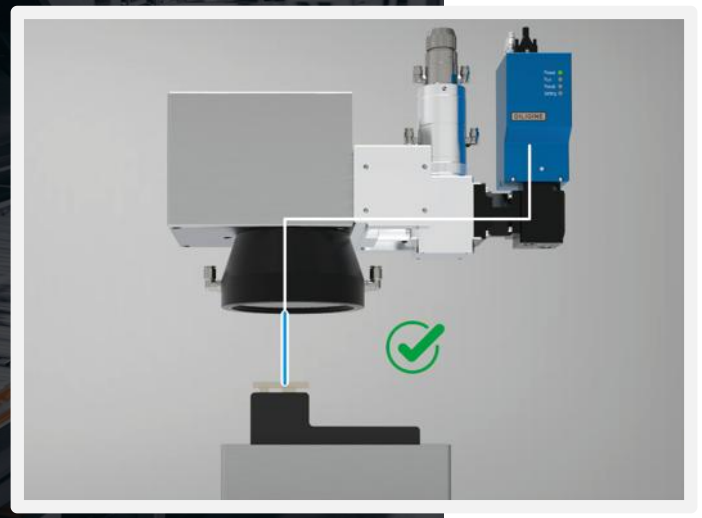


Displacement of Measuring Points

Due to mechanical repeatability errors, there is a 1.5% probability that the detection point lands on the fixture or rivet, causing the measured distance to deviate upwards by 9mm or 12mm. Incorrect servo distance compensation leads to false welding.

Long Cycle Time (CT)

Each mechanical movement takes about 1 second, with a total movement time of approximately 60 seconds.



No Measuring Point Displacement

The welding and detection points align, reducing the occurrence of false welding.

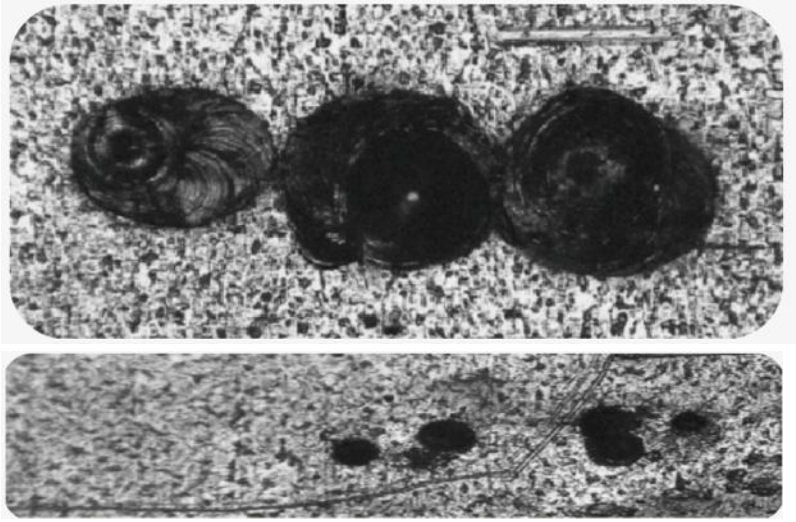
Short Cycle Time (CT)

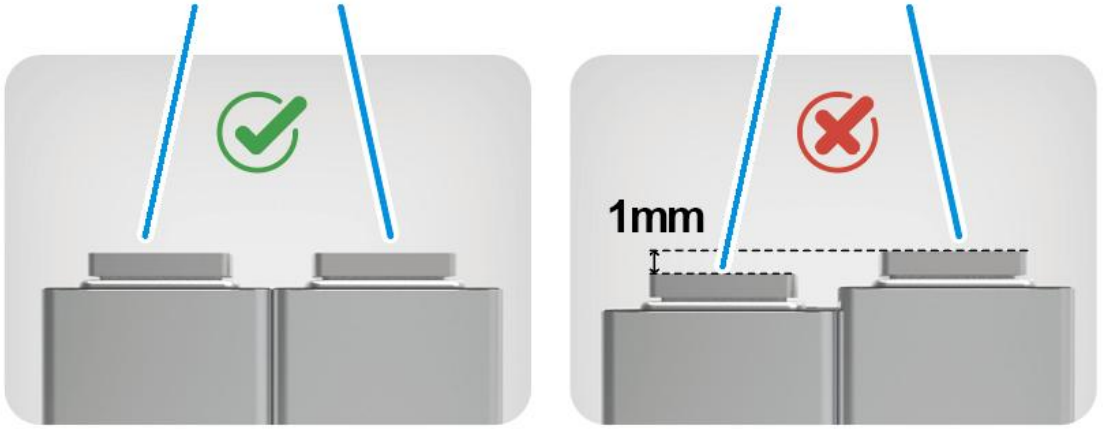
Saves 60 seconds per workpiece by reducing 60 mechanical movements. Saves 16% of welding time per PACK.

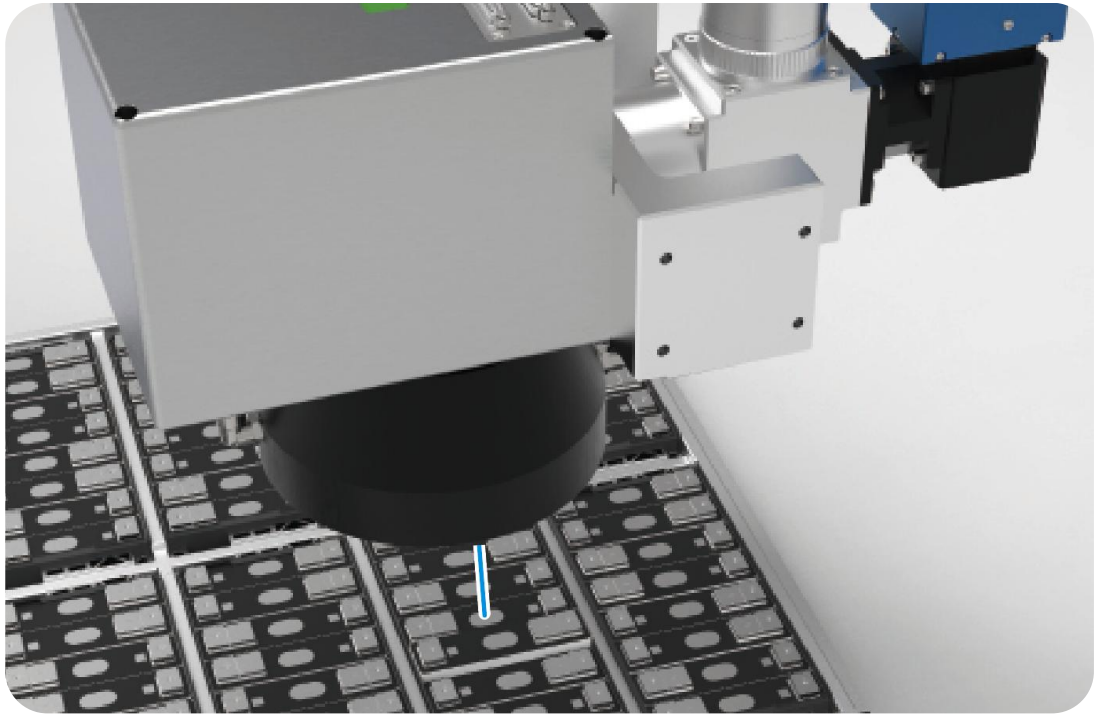
Connector Sheet Welding

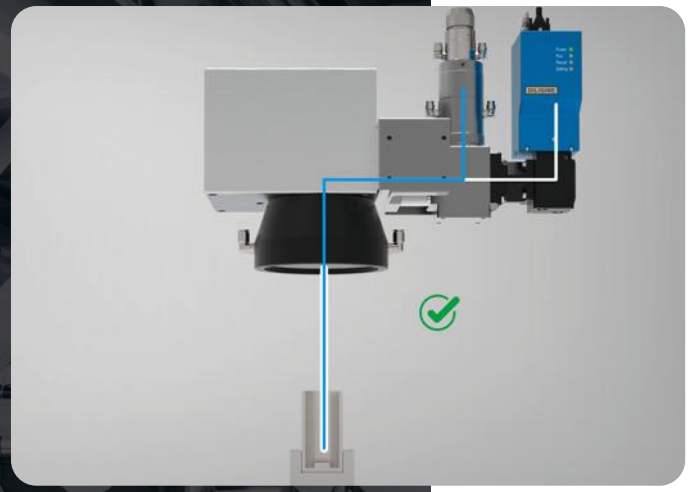
Independently detects multiple welding areas; Identifies various out-of-focus distance deviations; achieves stable and fast detection.

Welded products on site







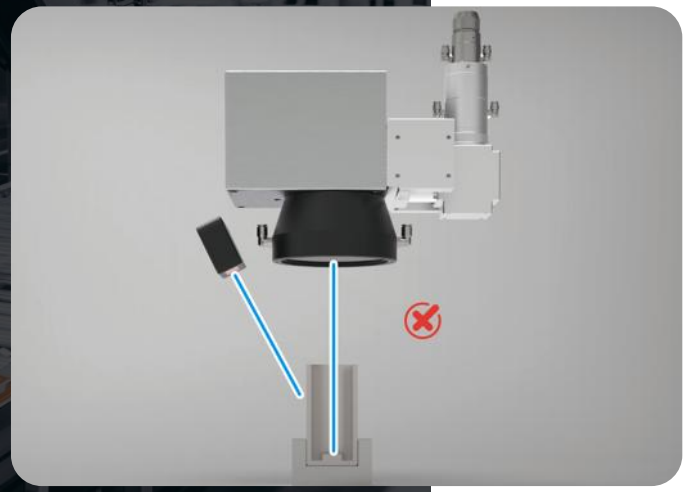


Displacement of Measuring Points

Due to mechanical errors, there is a 1% probability that the welding point lands on the fixture edge.The measured distance increases by 0.4mm, leading to false welding.

Optical Component Abnormalities

Air-cooling issues may cause lens curvature anomalies, leading to defocus and batch false welding.



Optical Component Abnormalities

The detection and welding points are the same, eliminating displacement issues.

Optical component anomalies can be detected

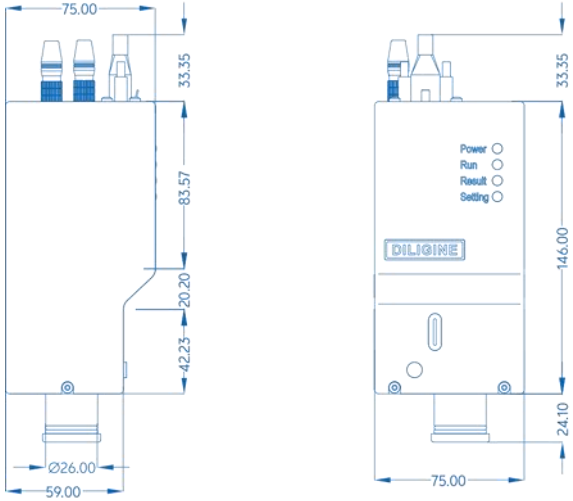
The coaxial principle ensures the detection light and laser beam share the same path. If an optical component malfunctions, the detection value triggers an error warning, reducing losses.



LFS
Laser Focus Sensor

Response Time	⩽100ms (single cycle ~15ms)
Measurement Accuracy	Maximum 50μm ※1
Measuring Distance	Depends on laser welding head length
Measuring Range	⩾10mm ※2
Light Source	940nm
Integration Options	SDK provided for customer intergration
Communication Protocols	TCP / IP /Analog/ IO
Interface Type	I/O, 100M/Gigabit Ethernet, AO
Power Supply	DC±12V
Protection Level	IP50
Operating Temperature	+5°C to +55°C
Relative Humidity	⩽90%

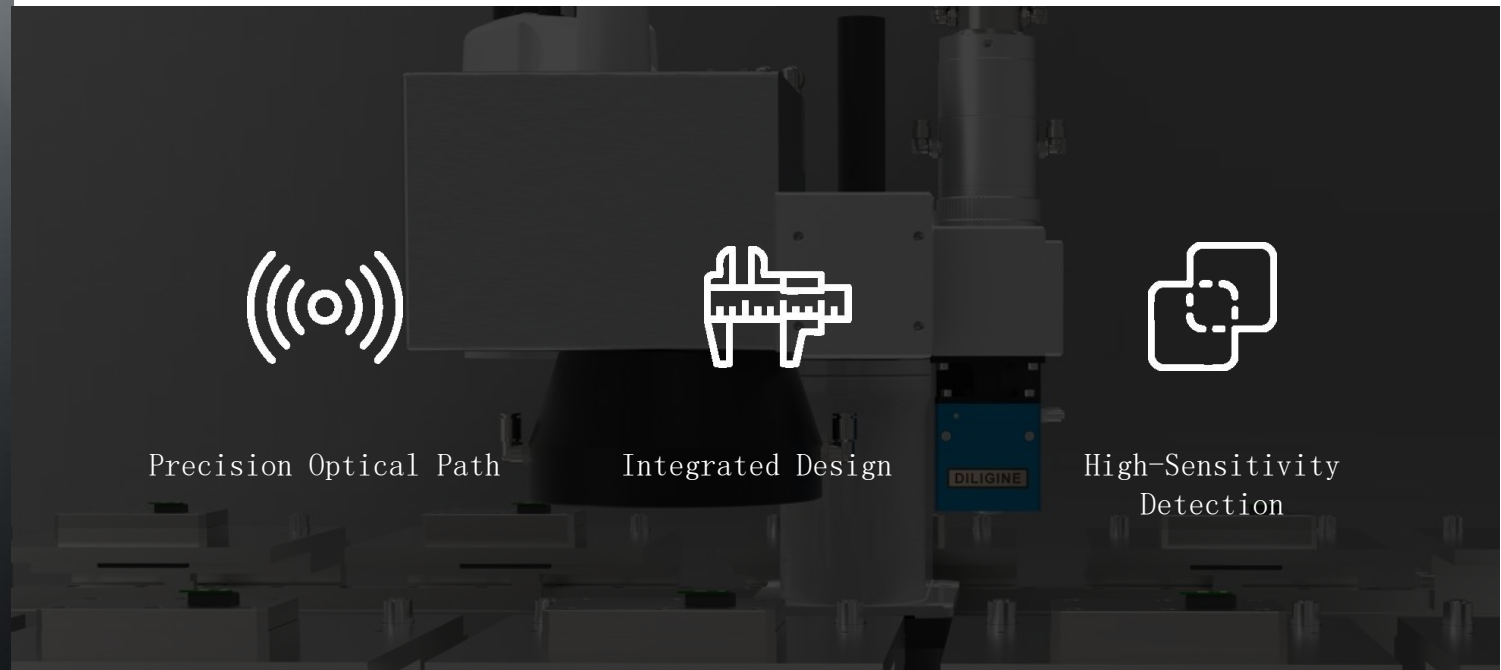
Note: ※1 Affected by workpiece surface roughness and laser head focal length ※2 Depends on focusing lens focal length
※3 15min preheating required before use





LPM
Laser Power Monitoring

The power sensing module is specifically designed to monitor laser power fluctuations in real-time. It ensures stable laser output during laser processing, maintaining power stability throughout the manufacturing process.

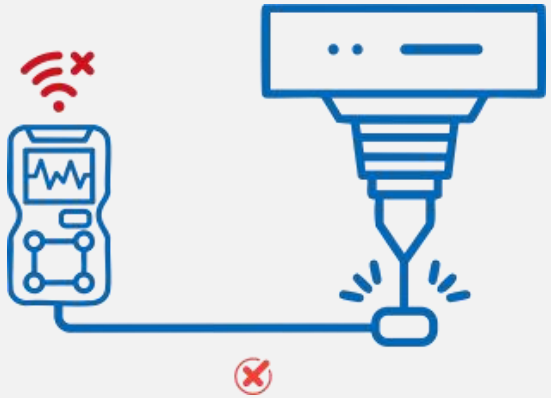


Precision Optical Path

Integrated Design

High-Sensitivity Detection

Challenges in Traditional Detection Methods



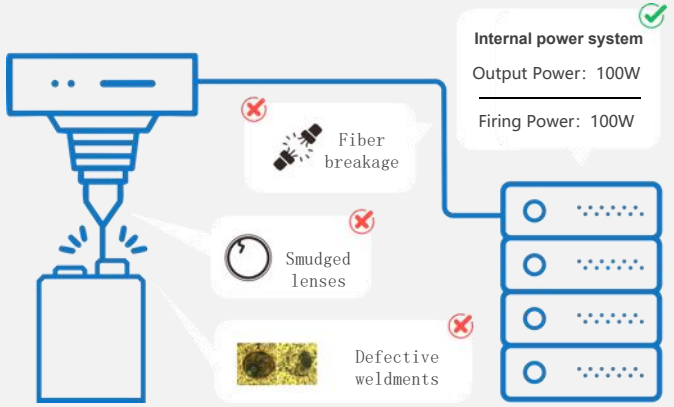
Unable to assess laser energy intensity in real-time

Offline power detection measures the laser’ s standalone output, not the actual power used for workpiece processing, making real-time monitoring and accurate welding power recording impossible.



Difficult to achieve product issue traceability

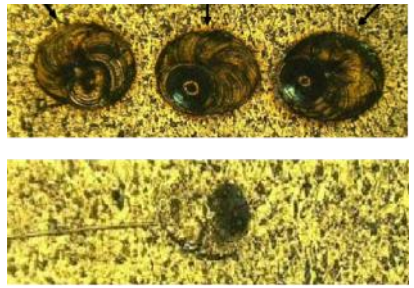
Detection records only capture independent laser output power and cannot be directly correlated with individual products, making it difficult to trace product issues.



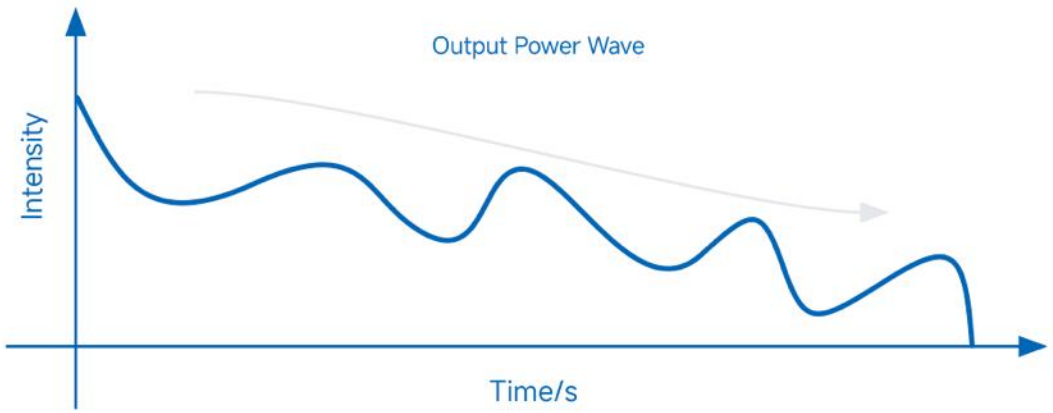
The internal power system struggles to handle external issues

Contamination of collimating lenses, protective lenses, and QBH connectors reduces beam energy and quality, which can’ t be detected by the laser’ s internal power feedback system.

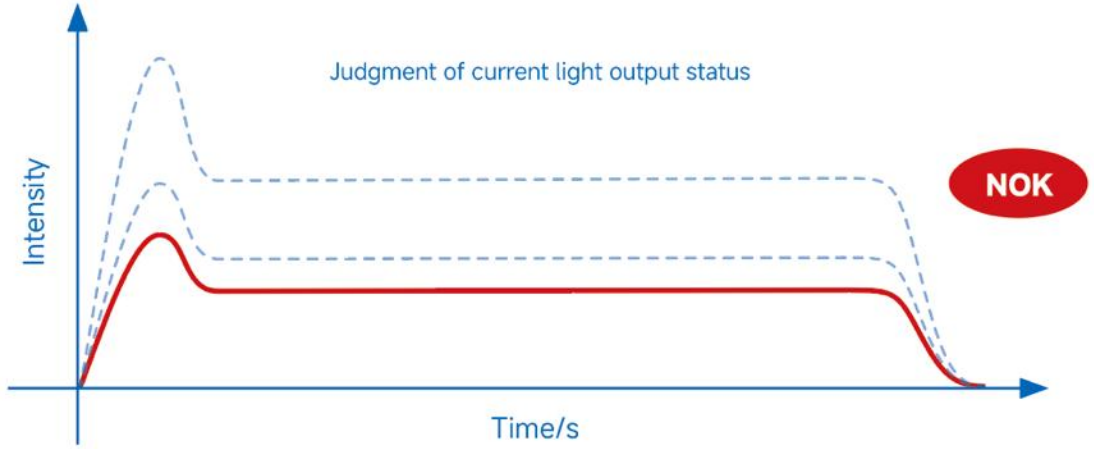
Diligine Online Laser Power Monitoring Solution



Power fluctuation defects appear



Diligine's laser power monitoring system can analyze welding power data to detect power fluctuation trends and provide early warnings for power anomalies. It performs real-time online monitoring of the current welding output power.

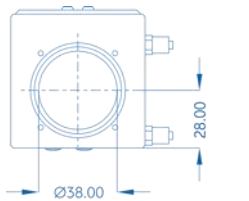


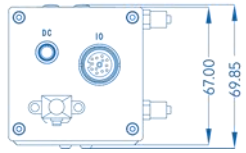
The system can be configured to automatically detect whether each laser output power falls within the allowable fluctuation range. It performs real-time online monitoring of the current welding output power.

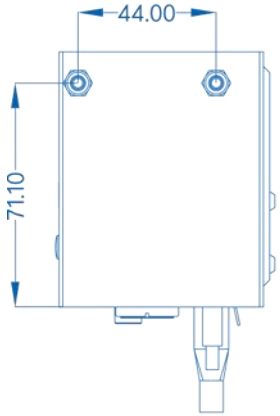


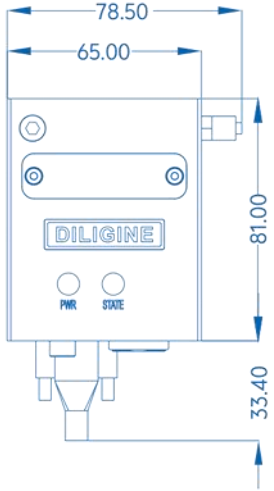
LPM
Laser Power Monitoring

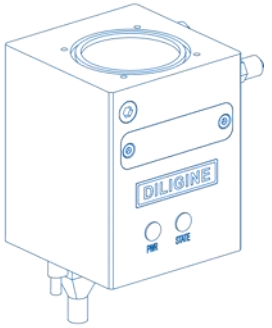
Applicable Laser Power	20W-6KW
Induced Spectral Range	Blue light, green light, near-infrared light, other customizable wavelengths
Compatible Laser Sources	Fiber laser, Disk laser, Diode laser, YAG laser, blue laser, pulsed laser, ring laser
Detection Accuracy	≤±2%
Cooling Methods	Air-cooled/Water-cooled
Protection Level	IP 50
Collection Frequency	MAX 200kHz
Exception Type	Power attenuation, abnormal power increase, collimating lens contamination
Applicable Scenarios	Laser welding, laser cutting, laser additive manufacturing, laser cleaning, laser marking, etc.
Operating Temperature	+5°C 至 +55°C
Relative Humidity	≤ 90%
Communication Protocols	TCP/IP、IO
Interface Type	I/O, Gigabit Ethernet
Power Supply	DC ± 15V

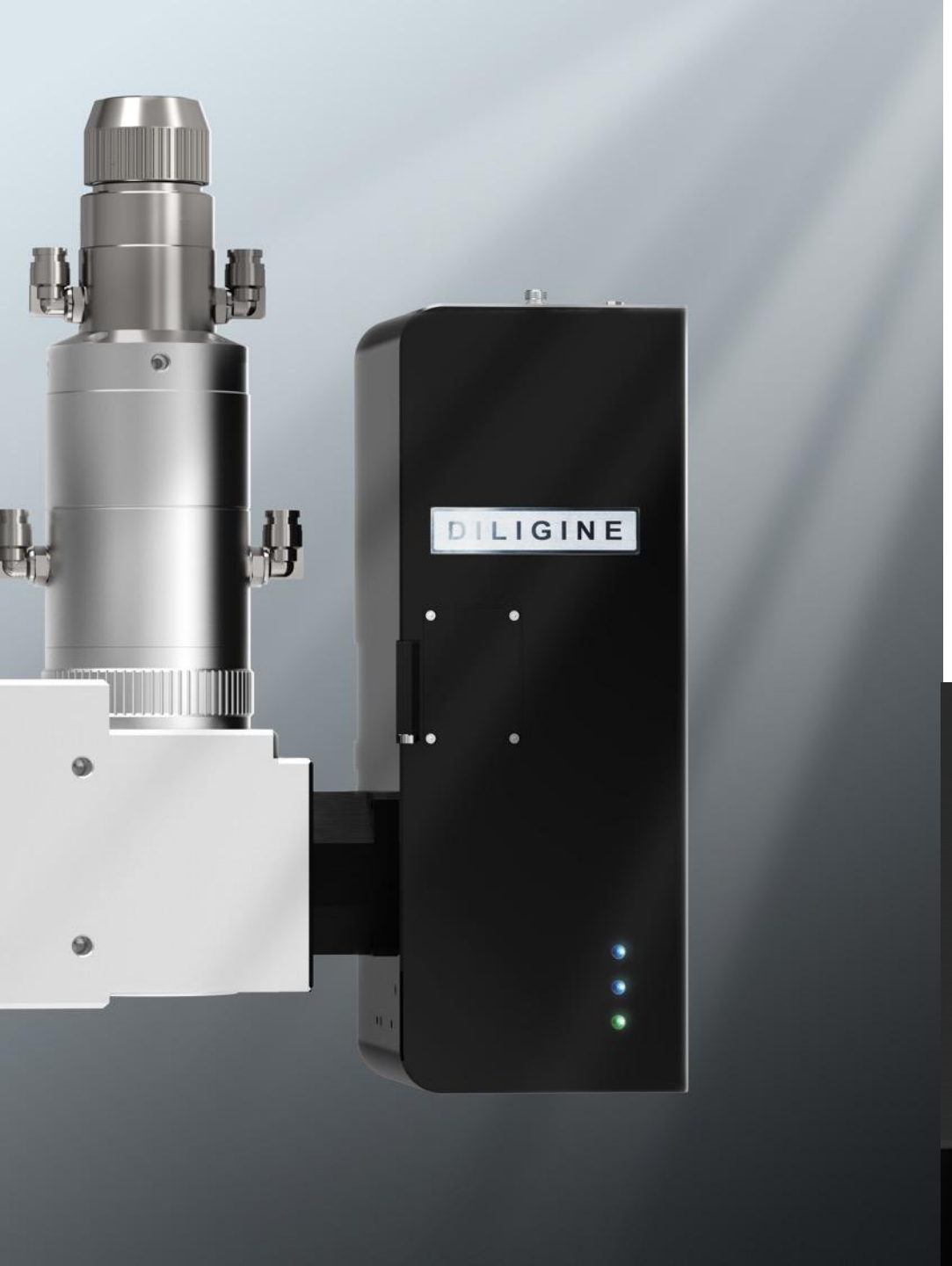






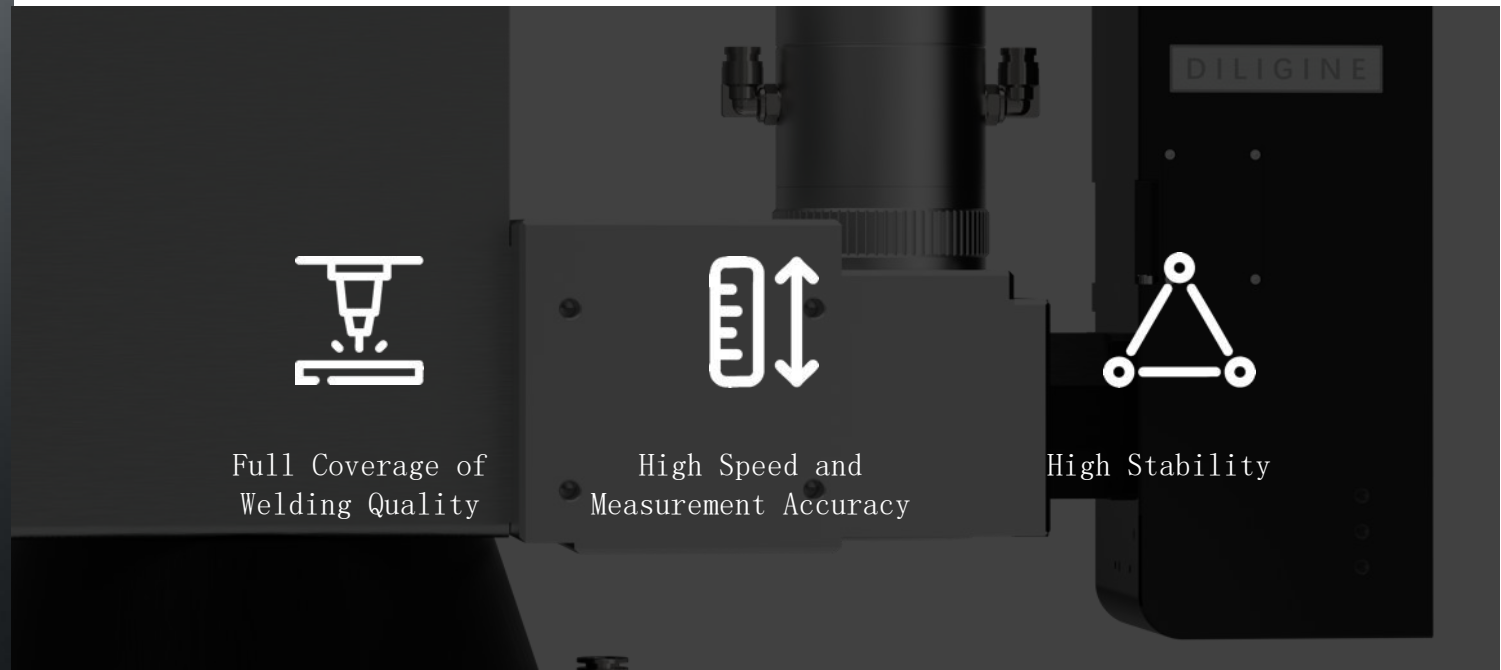






WDM
Welding Depth Measurement

The Laser Welding Depth Measurement System (WDM) is a laser welding on-line inspection system. Using the function of OCT to measure the distance in laser welding. The system compares the workpiece measurement signal with the reference signal to extract molten pool depth information, performs depth qualification, and simultaneously measures both the workpiece surface topography and keyhole penetration depth.



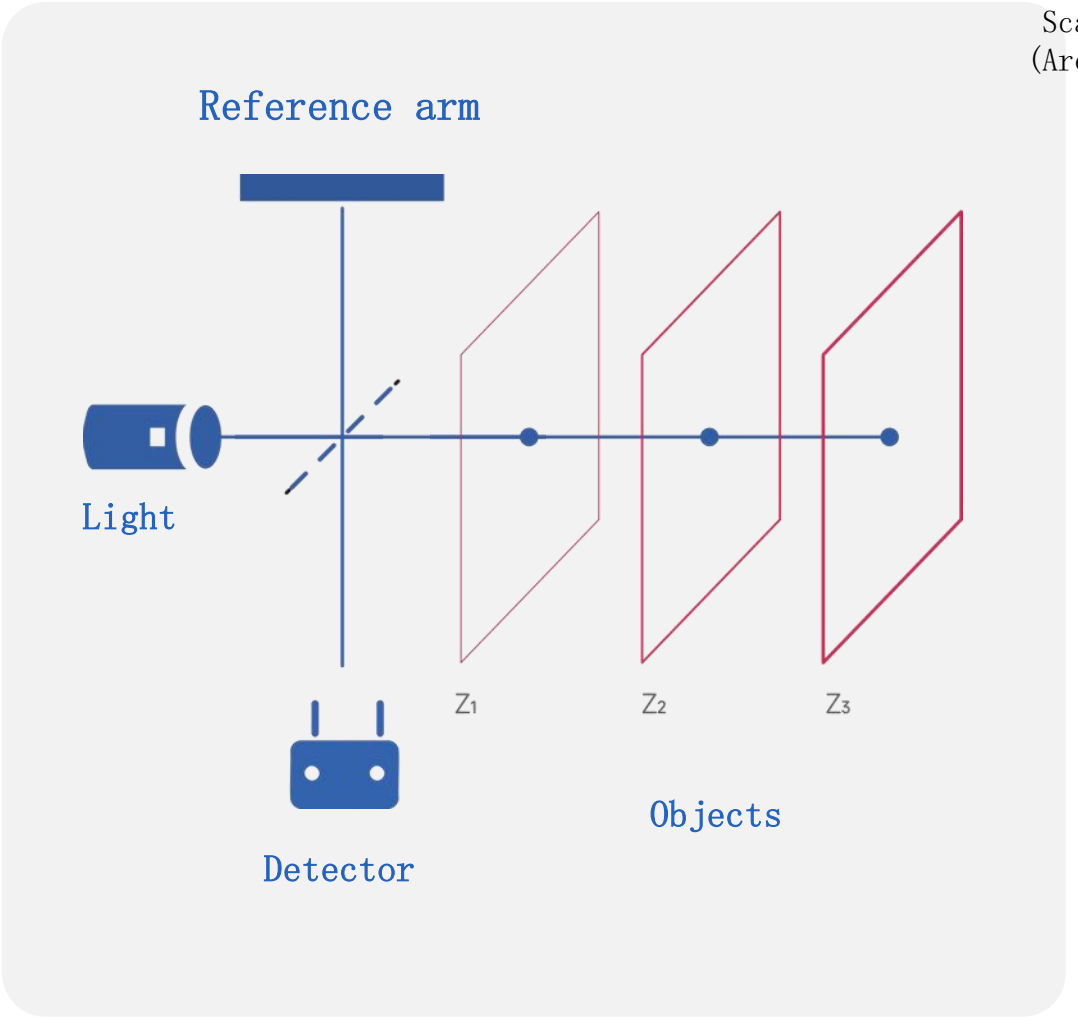
Full Coverage of Welding Quality

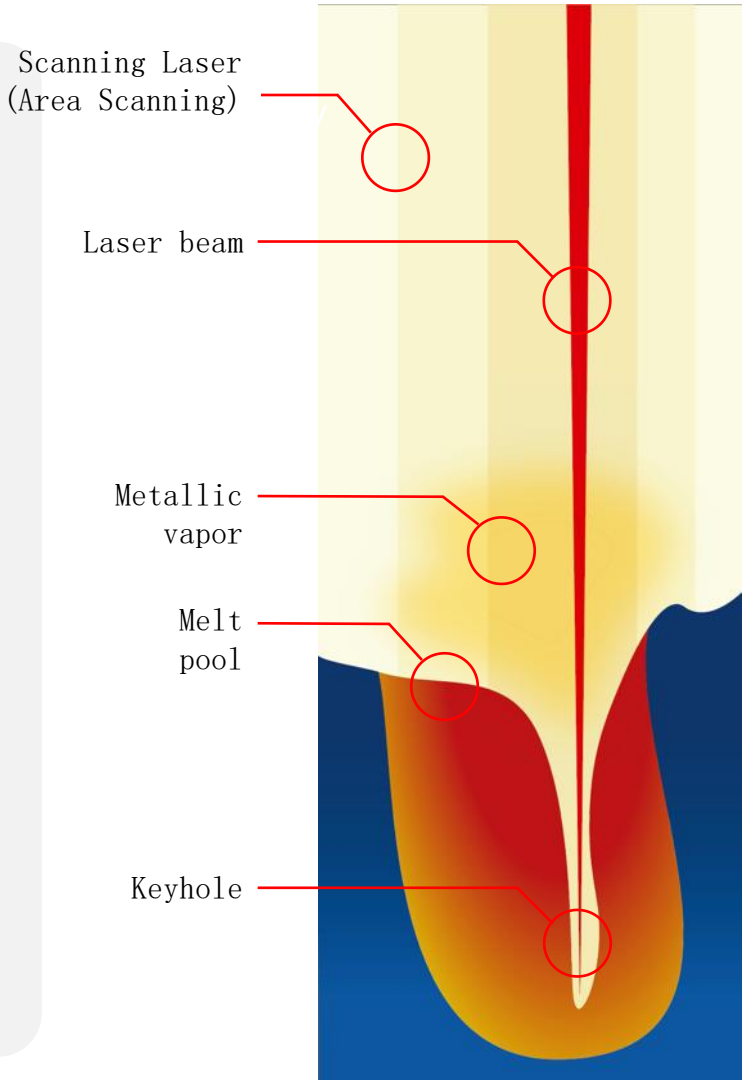
High Speed and Measurement Accuracy

High Stability

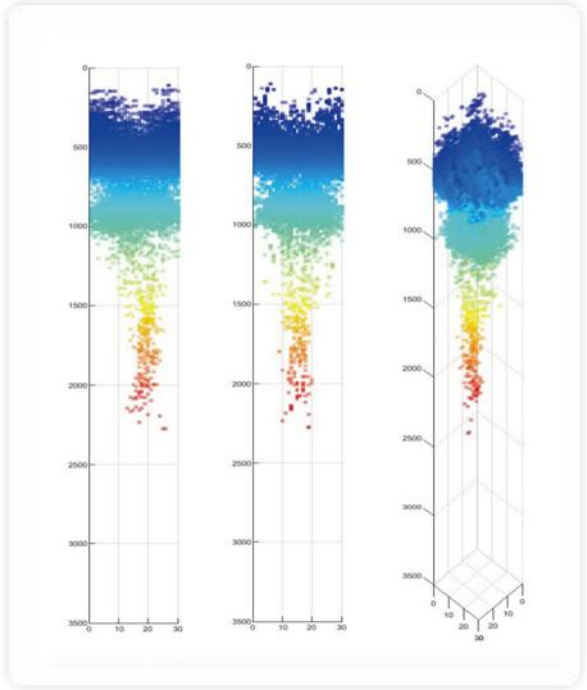
Operating Principle

Utilizing the principle of light interference, the time delay of reflected light on the workpiece is measured to obtain information such as weld seam position, melt depth and melt width.

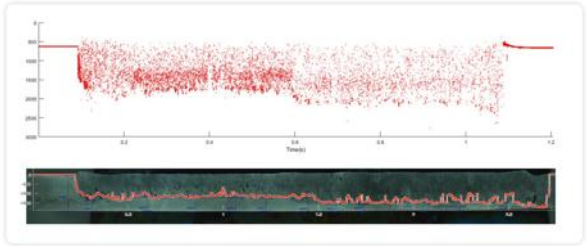




The shape of keyhole



Depth of Melting Measurement

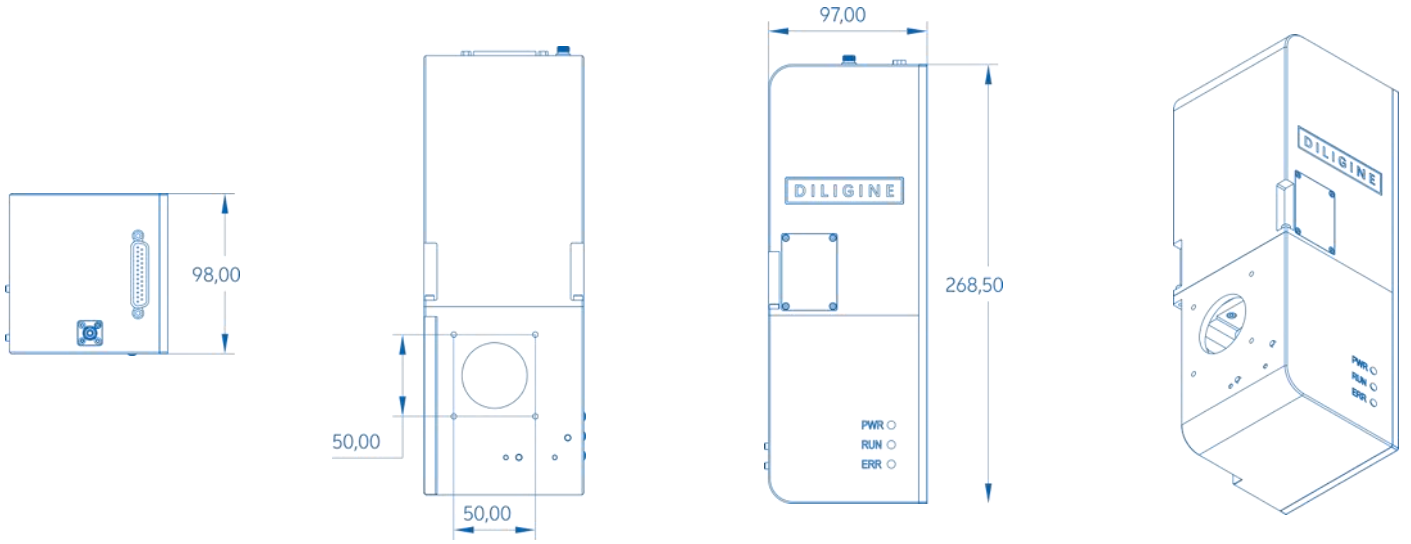




WDM
Welding Depth Measurement

Wavelength	800-900nm
Range	9mm
Vertical Resolution	10μm
Sampling Frequency	Max 250kHz
Spot Size*	50μm
Rated Power	<40W
Rated Power（W x D x H）	117mm x 318mm x 128mm
Signal Acquisition Controller Dimensions（W x D x H）	482mm x 334mm x 176mm
Depth of Melt Scanner Compatibility	Compatible with fixed camera ports
External Communication	TCP/IP, UDP, I/O, Analog Signal (0-10V)
Operating Temperature	+10°C to +45°C
Relative Humidity	⩽90%
Protection Level	IP60

*Depends on processing head optical parameters





OTS
Optical Tomography Scanner

Diligine's latest optical layer scanning measurement instrument adopts Optical Coherence Tomography (OCT) imaging technology, which is not affected by material or color. The high-speed scanning galvanometer, combined with a telecentric lens, enables seamless online 3D topography measurement and quality inspection.

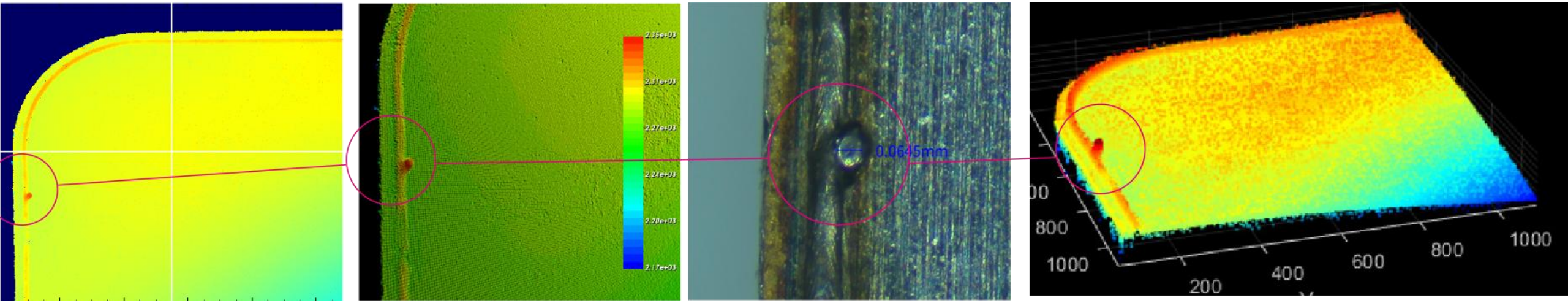


Capable of Measuring Various Workpieces

High-Precision Online Measurement

High Stability

DILIGINE
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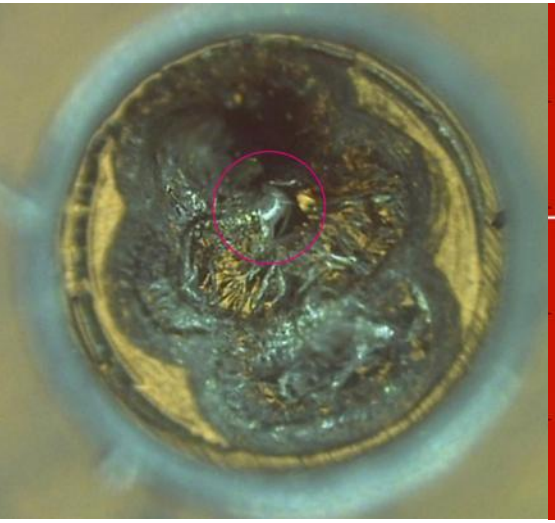


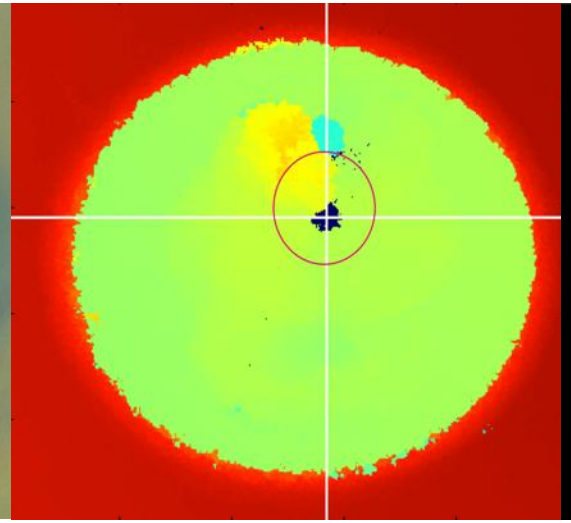
Cover Hole Explosion

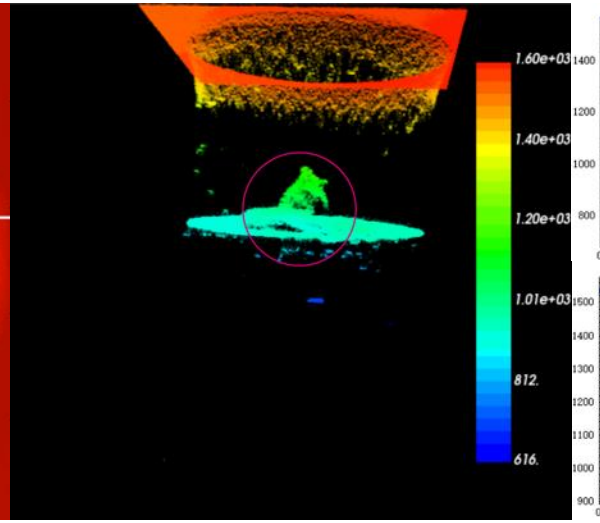
Cover Hole
Explosion

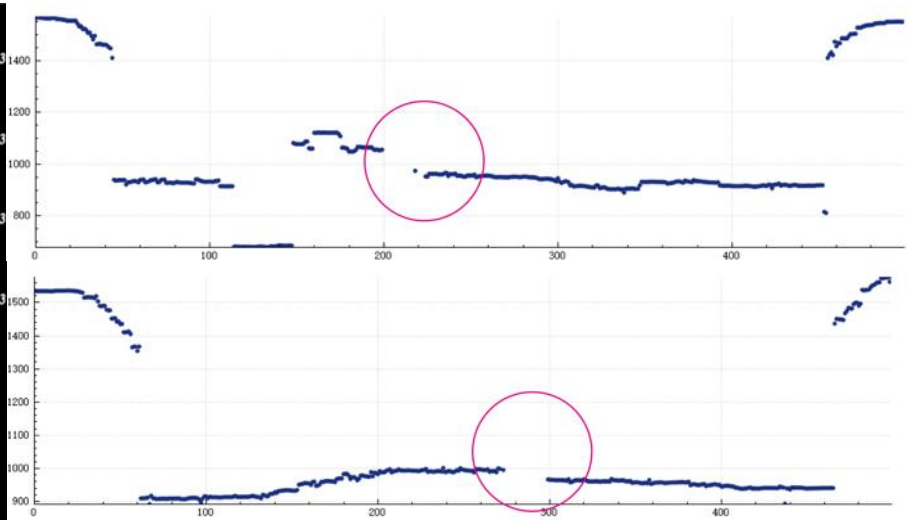
Microscope shows defect width of approximately 0.0645mm. OTS scans the entire area to locate the defect, with a protrusion height of about 60μm.

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Square Battery Cathode Burn Through

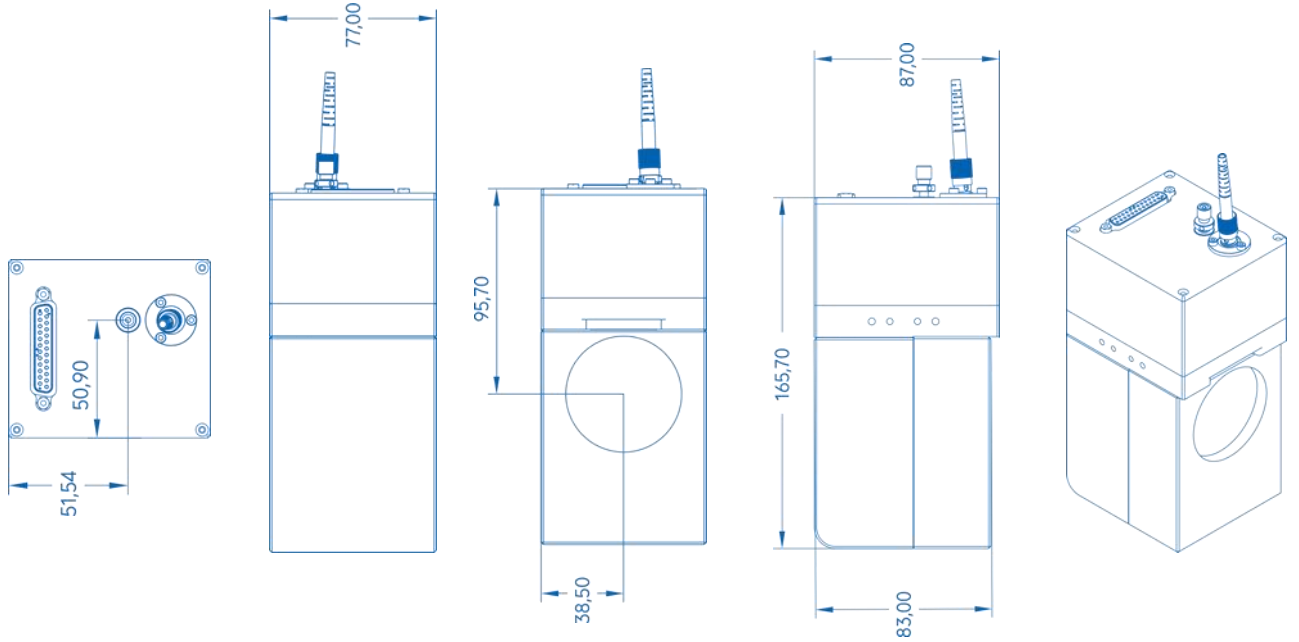
OTS scans the entire area, detecting fluctuations in the welding region. A small hole without reflected signals appears in the middle area, indicating burn-through.



OTS

Optical Tomography Scanner

Product Model	OTS30	OTS80
Sampling Frequency	Max 250kHz	Max 250kHz
Distance	94mm	200mm
Scanning Area Diameter	30mmX30mm	80mmX80mm
Horizontal Resolution	11μm	15μm
Vertical Resolution	1μm	1μm
Spot Size	22μm	30μm
Power Supply	±15V	
Rated Power	90W	
Operating Temperature	+10°C to +45°C	
Relative Humidity	⩽90%	
Protection Level	IP60	



德擎光学科技
DILIGINE

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