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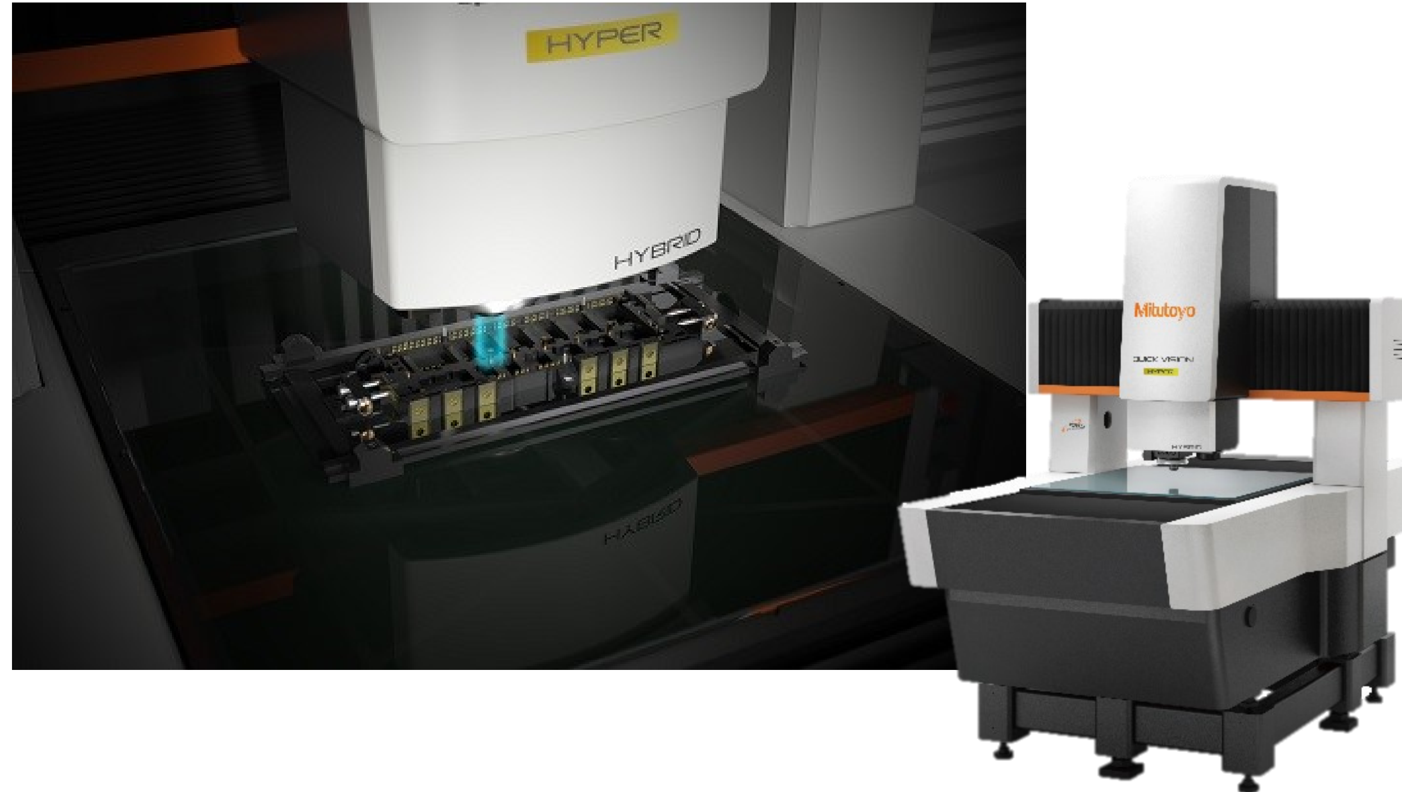
Mitutoyo

Manufacturing Technology Conference 2024

Presenter:
Ron Meijer, Mitutoyo Europe GmbH

About solving measurement problems for advanced packages



Introduction

Demand for semiconductors is increasing for IoT, 5G communications, automotive CASE, and smart factories.

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The changes of semiconductor packages and measurement problems

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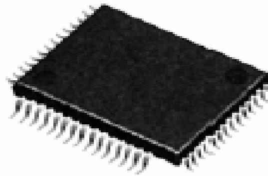
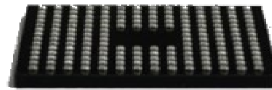
Calculator/clock

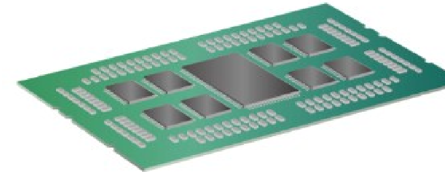
Large computer

PC/Game machine

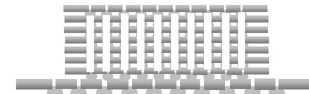
Data center/5G base station







MCP Multi Chip Package



TSV Through Silicon Via

Highly integrated package

Smartphone

FOWLP/FOPLP

Fan Out Wafer Level Package/Fan Out Panel Level Package

DIP

Dual-In-line Package

QFP

Quad Flat Package

BGA

Ball Grid Array

FCBGA

Flip Chip Ball Grid Array

Measurement Problems (DIP / QFP)

・Lead frame dimension measurement
・Inner lead tilt and twist
・Island height
・Bonding loop height
・Mold dimensions
etc.

Super QV/Hyper QV
Improving the accuracy of CNC image measuring machines

Measurement Problems (BGA)

・Outer diameter of organic substrate
・Bump coplanarity
・Copper wiring Line /Space
・Conductor thickness
・Lamination misalignment of multi layer PCB
etc.

QV Hybrid
Non-contact displacement sensor
Multi-sensor machine

Measurement Problems (FCBGA)

・Copper wiring L/S 3D measurement
・Via diameter 3D measurement
・Conductor thickness
・Surface roughness
・Lamination misalignment of multi layer PCB
etc.

QV WLI
Equipped with white light interferometer

Measurement Problems (3D Stacking)

・Die bonder position accuracy measurement
etc.

QV Pro / STREAM
High throughput measurement

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What is a Vision Measuring Machine?

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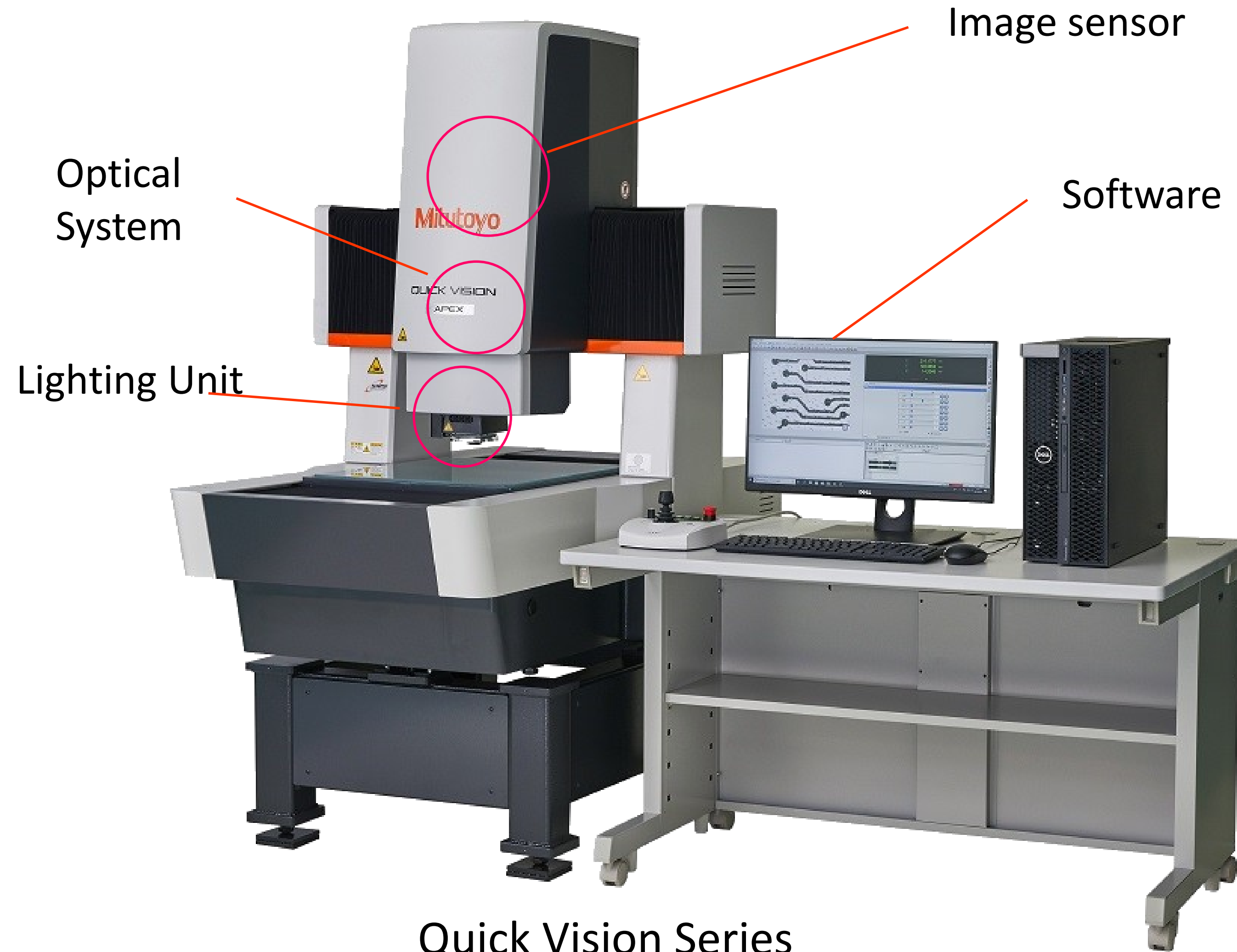

Quick Vision Series

Basic functions of Vision Measuring Machine

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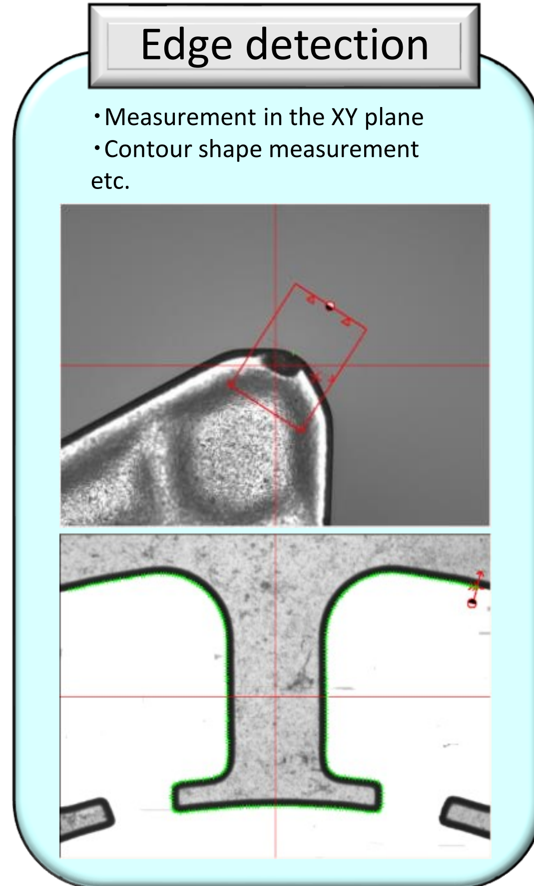
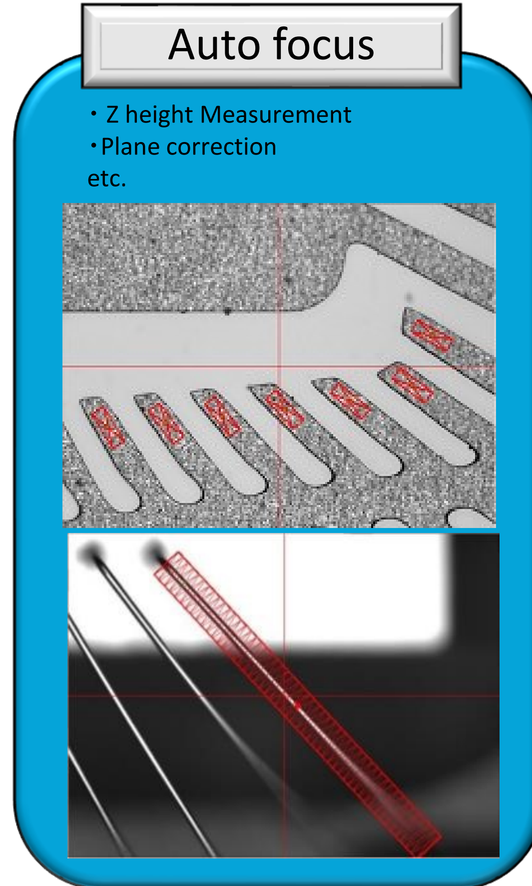
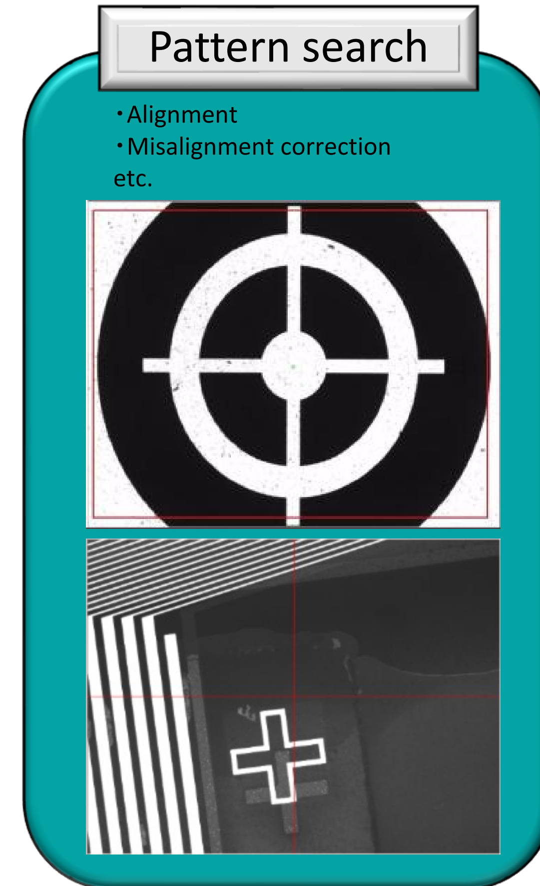
The vision measuring machine performs measurements through the following processes.







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High-throughput vision measurement to improve productivity

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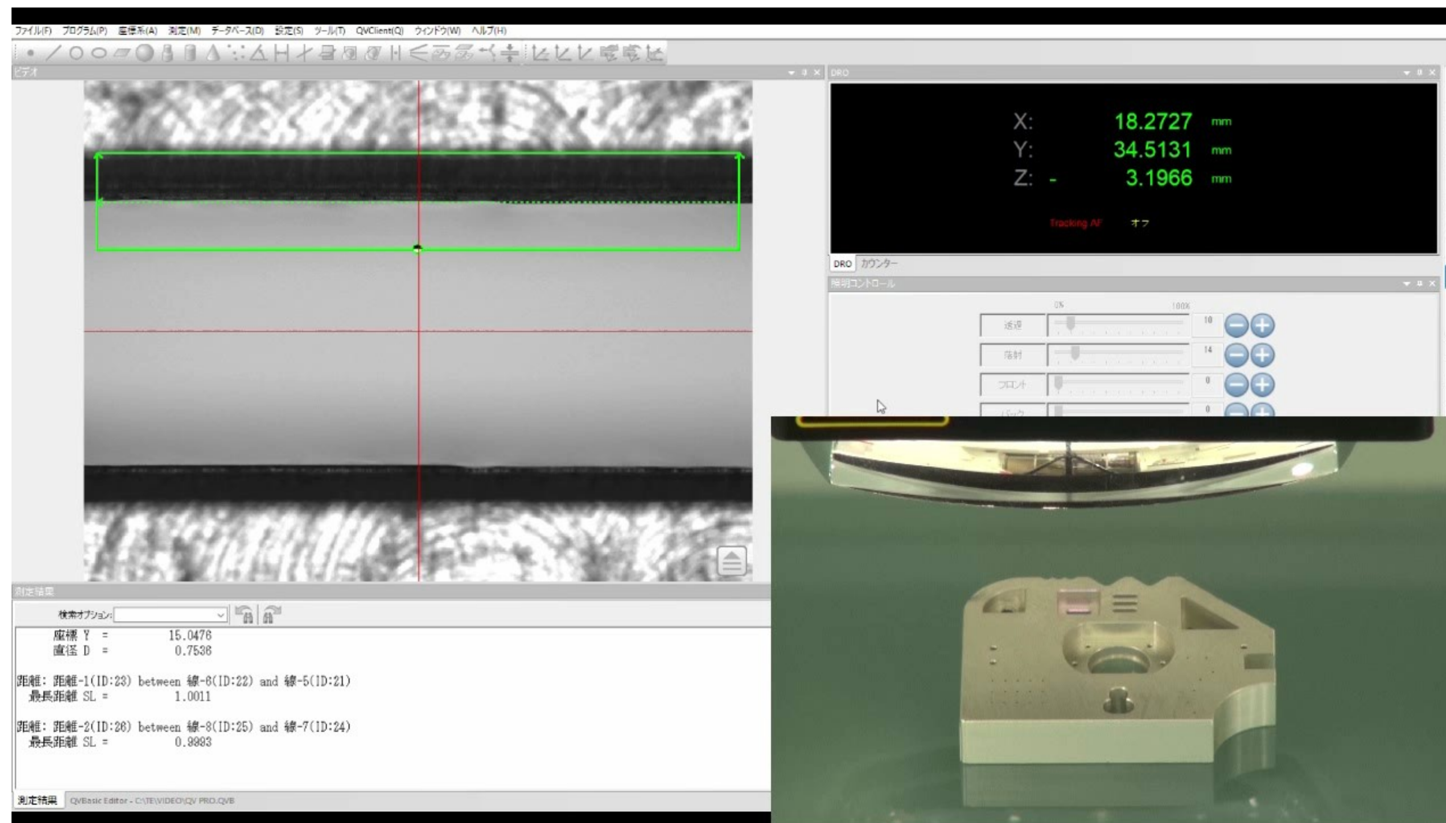
1. Strobe Snap New

All Quick Vision Pro models are equipped with strobe lighting.
The newly developed vision measurement function "Strobe Snap" achieves both high-throughput and high-precision measurements.



Edge detection：Strobe Snap **18s 40% Faster**

High-throughput vision measurement to improve productivity

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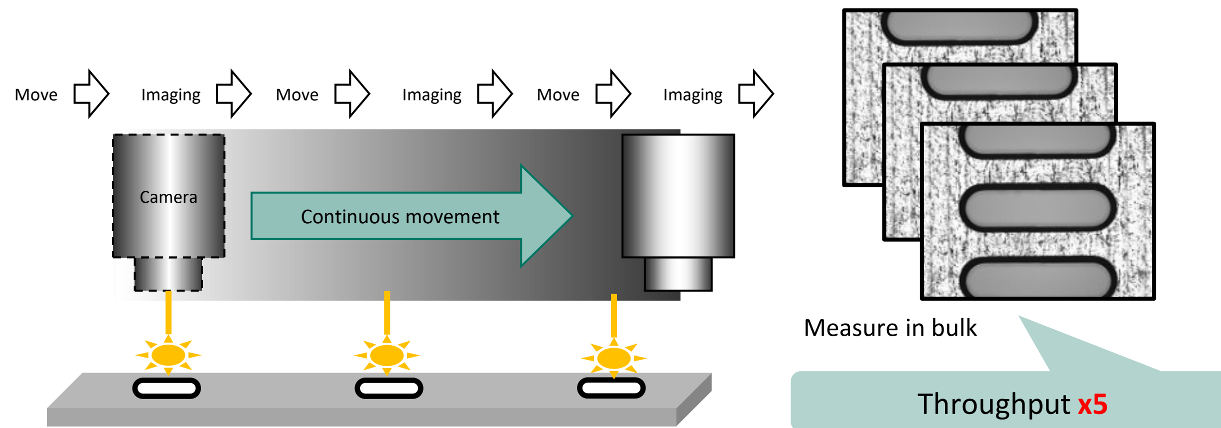
2. Stream function (option) New

The stream function achieves amazing high throughput with non-stop measurement that synchronizes the main unit drive and strobe lighting.

Stream function overview



Measure in bulk

Throughput x5

By synchronizing the XY drive and strobe lighting, capturing images intermittently without stopping the stage, and then performing batch measurements, measurement speed is greatly improved.

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High-throughput vision measurement to improve productivity

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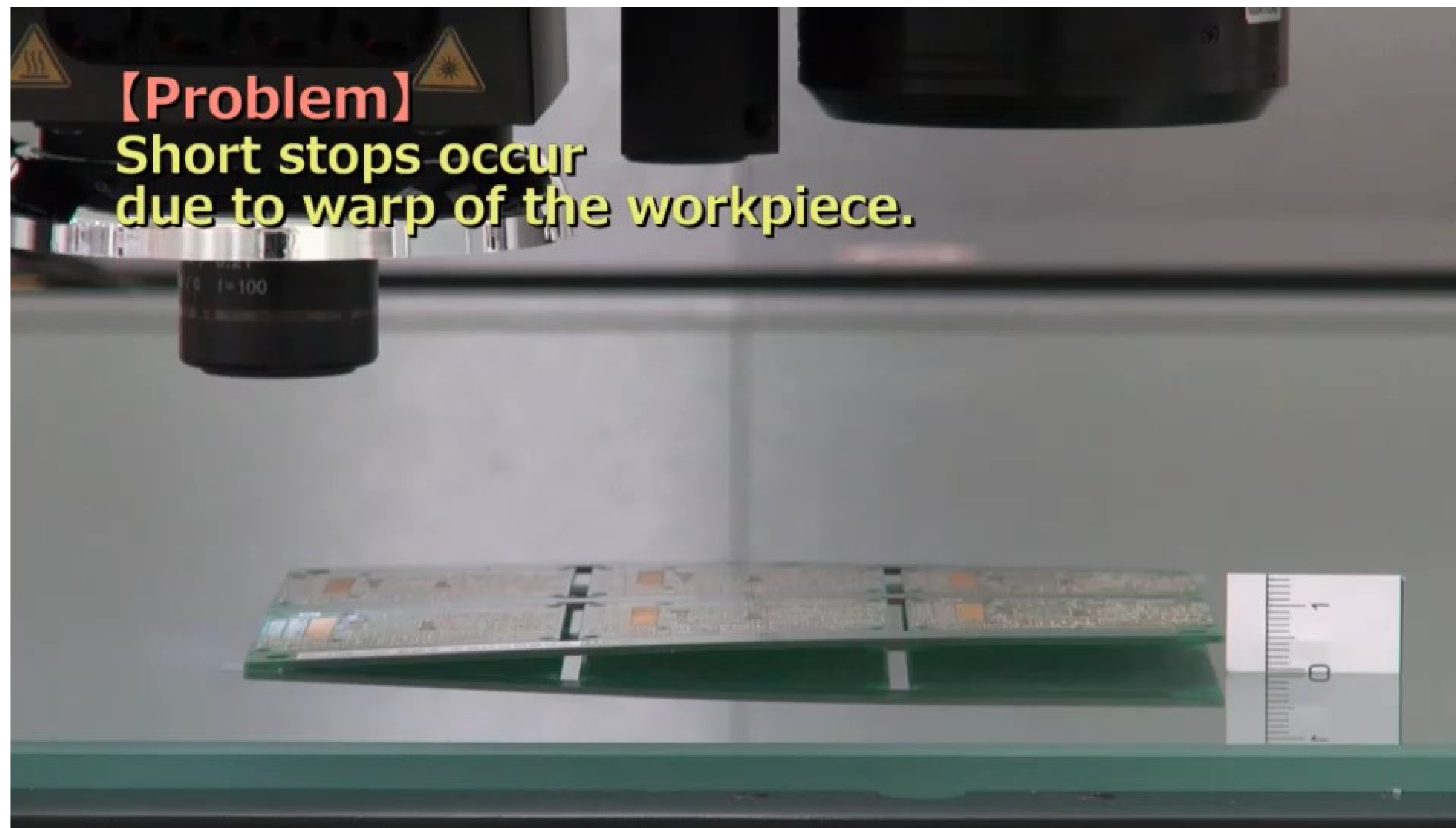
2. Stream function (option) New

Continuous element measurement can further reduce measurement time than strobe snap.
Quick Vision Pro, including HYPER machines, can be optionally upgraded to include Stream function.



High-throughput vision measurement to improve productivity

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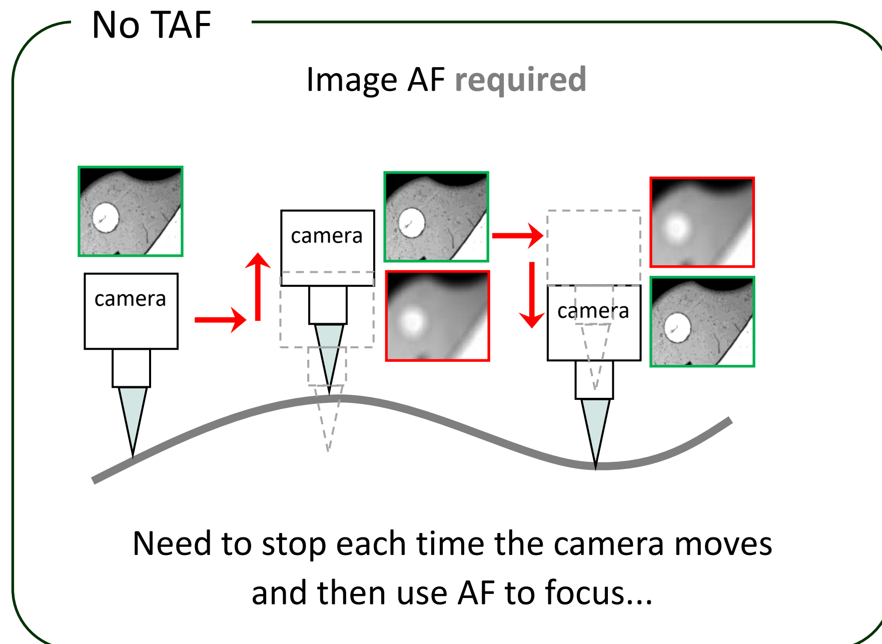
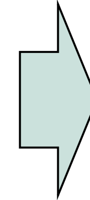
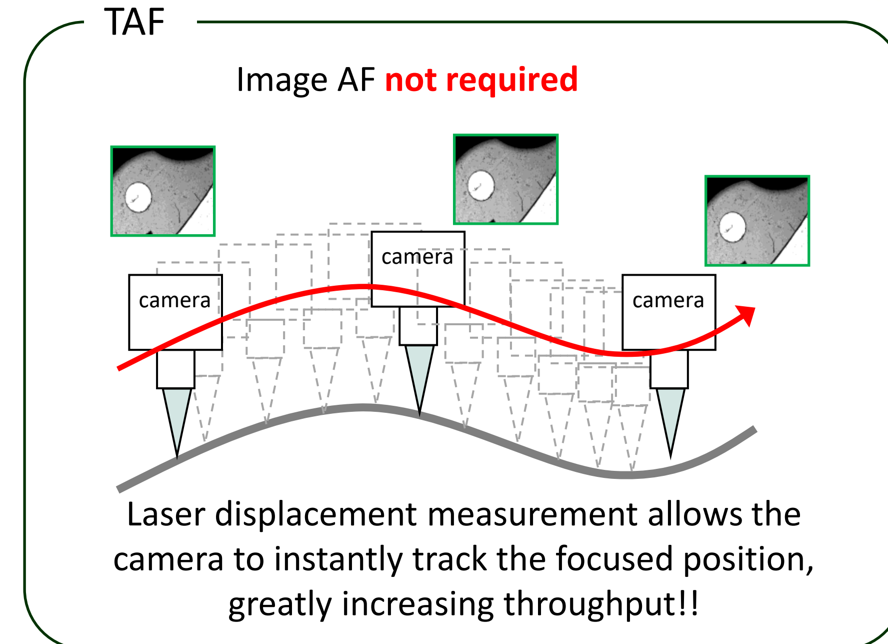
3.Tracking Auto Focus(TAF)

TAF works well with **strobe snap** and **stream** functions, which greatly increasing throughput.

TAF overview







Z tracking measurement
using **T**racking **A**uto **F**ocus

High-throughput vision measurement to improve productivity

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3. Tracking Auto Focus(TAF)

Using a laser, the camera can instantly track changes in the Z-axis height of the object being measured.

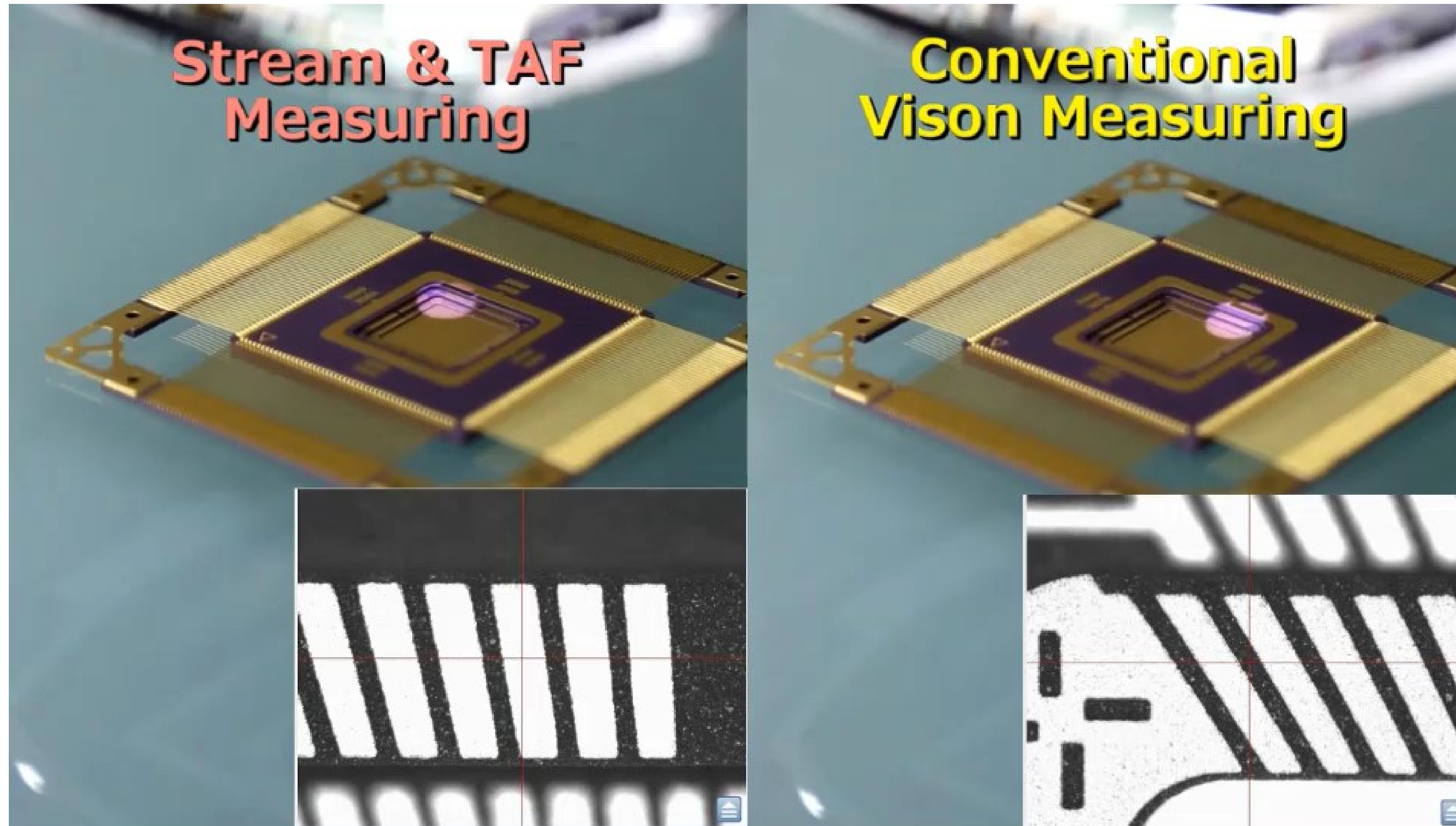
Electronic component
(Surface mount connector)

By using the Z-axis hold function, it is possible to track even non-continuous measurement surfaces.

High-throughput vision measurement to improve productivity

3. Tracking Auto Focus(TAF)

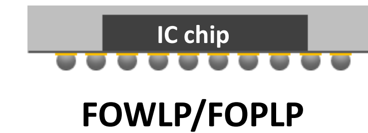
TAF works even more effectively in Strobe Snap and Stream functions, greatly increasing measurement throughput.



Measuring FOWLP/FOPLP using Stream function

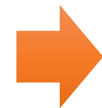
With FOWLP/FOPLP, etc., by measuring the positional and angular deviation of each chip, it is possible to output coordinate correction data for the equipment used for rewiring formation.

With the stream function and TAF, the position of each chip can be measured at high speed even if the workpiece is warped.

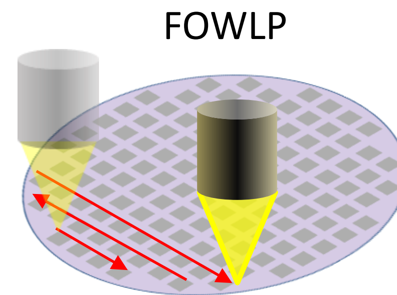


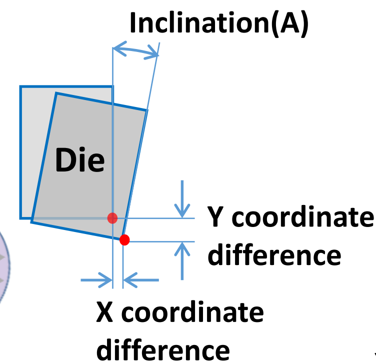
FOWLP/FOPLP

Die bonder



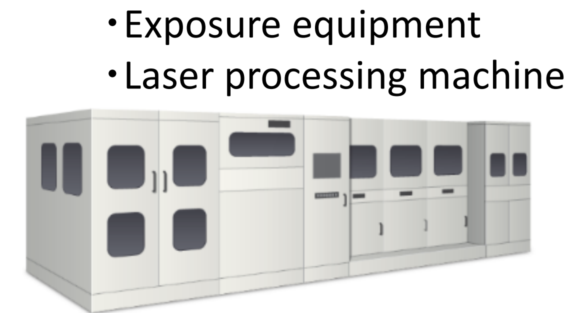
FOWLP





X,Y,A data

・Exposure equipment
・Laser processing machine



Quick Vision Pro

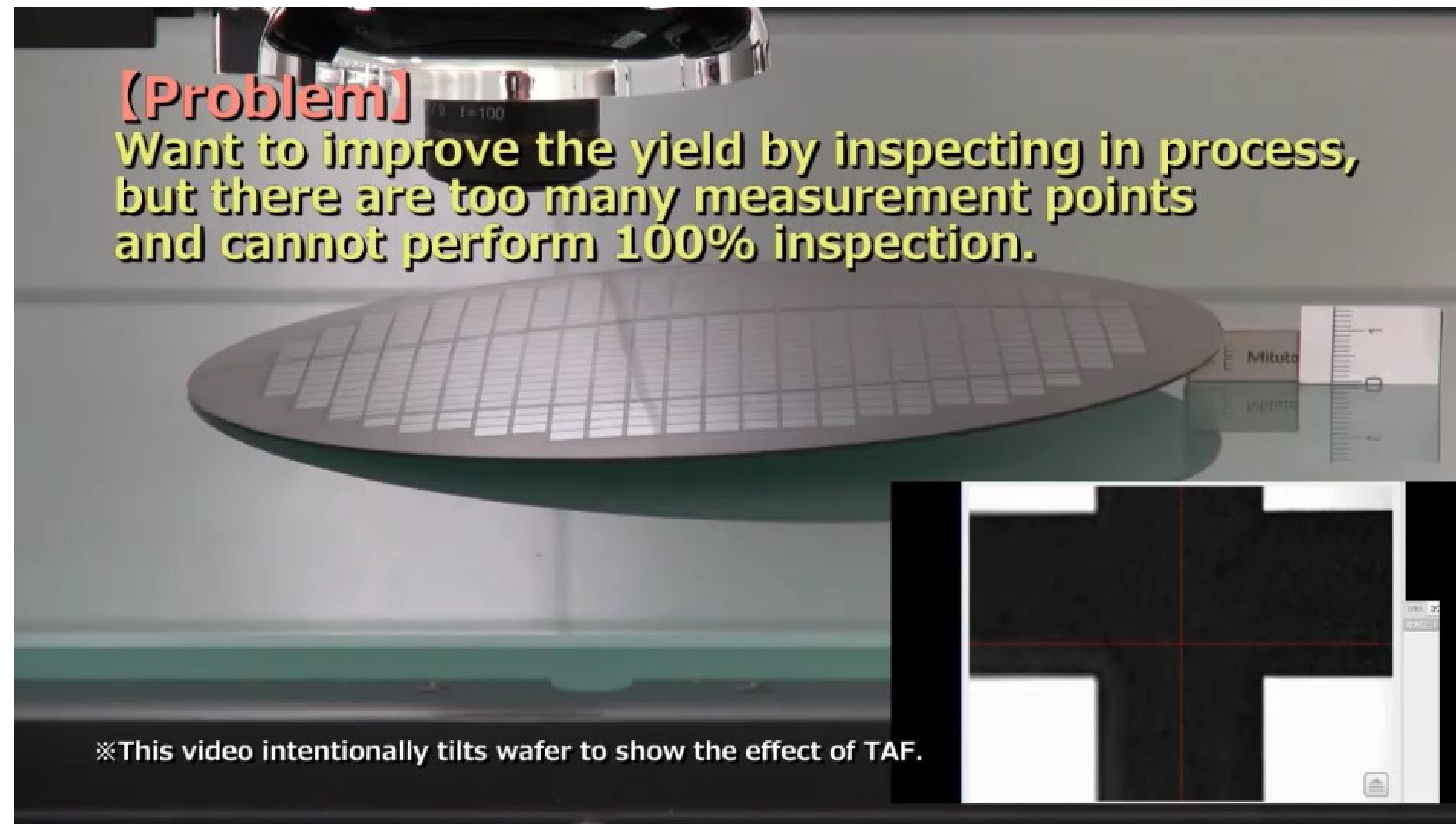
When measuring 25.400 chips, STREAM mode reduced measurement time by approximately **80%**!

	Normal mode	**STREAM mode**
All 25.400 pieces	About 183 min.	About 34 min.

Measuring FOWLP/FOPLP using Stream function

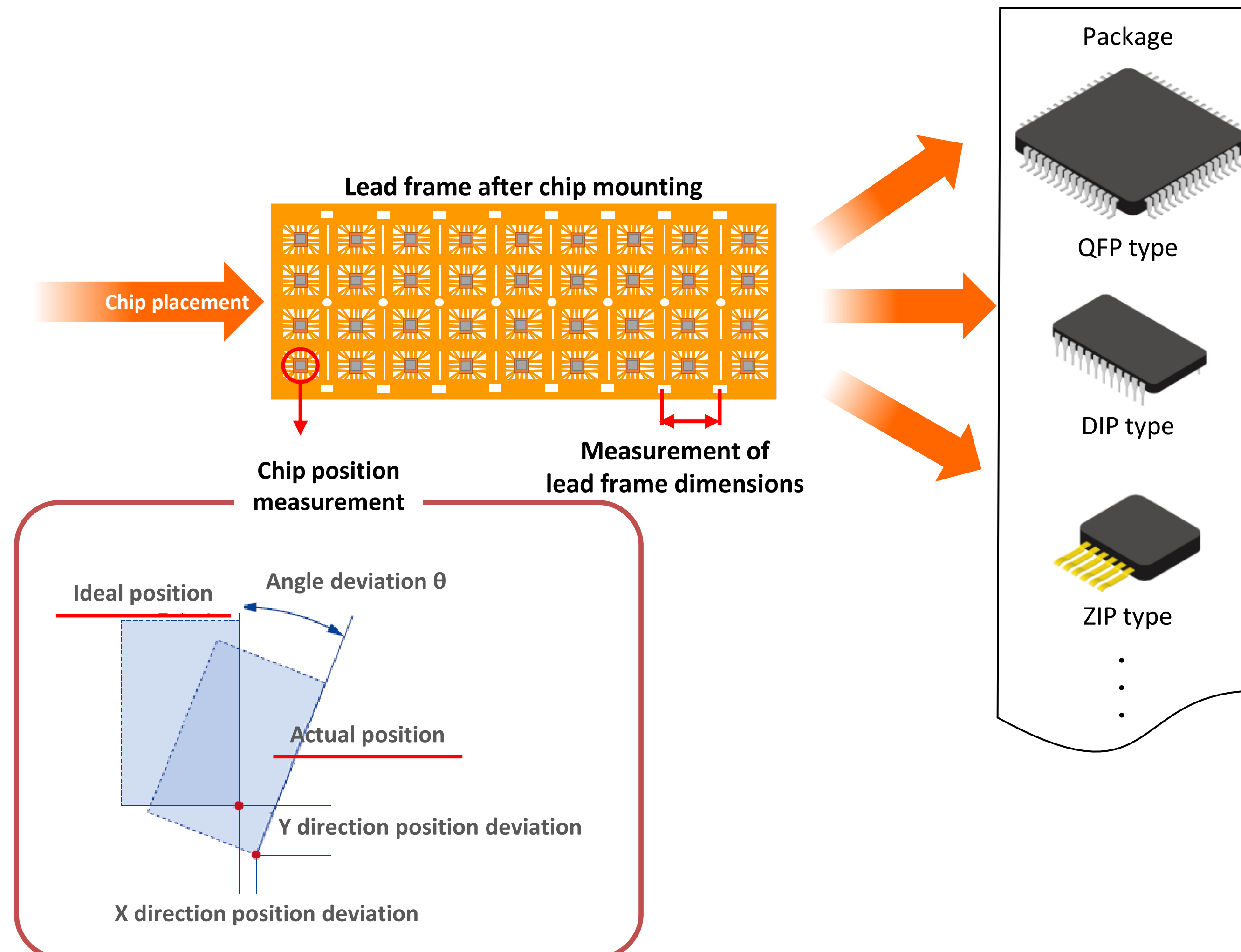
With FOWLP/FOPLP, etc., by measuring the positional and angular deviation of each chip, it is possible to output coordinate correction data for the equipment used for rewiring formation.

With the stream function and TAF, the position of each chip can be measured at high speed even if the workpiece is warped.



Power semiconductor package measurement using Stream function

TAF and stream functions can significantly reduce measurement time for warped workpieces or workpieces arranged at a constant pitch. Throughput can also be expected to improve when measuring lead frame dimensions and chip position on lead frames.



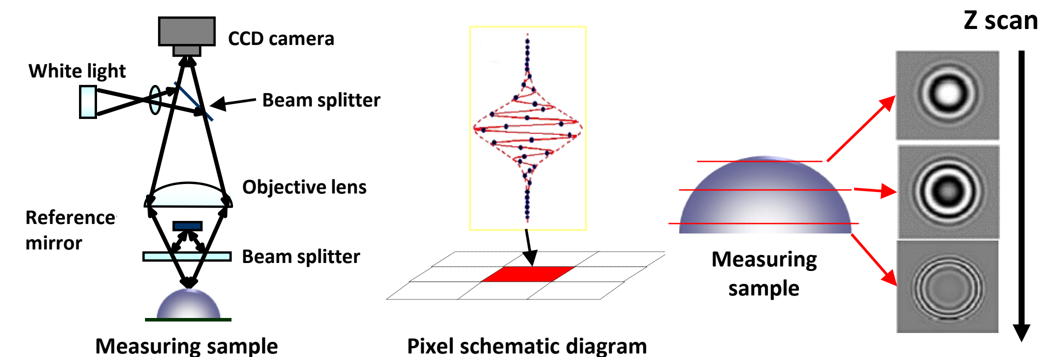
Quick Vision WLI Pro series

This is a complex measuring machine that enables 3D shape dimension measurement
and surface roughness analysis by equipping the vision measuring machine with a white light interferometer.

Main body specifications

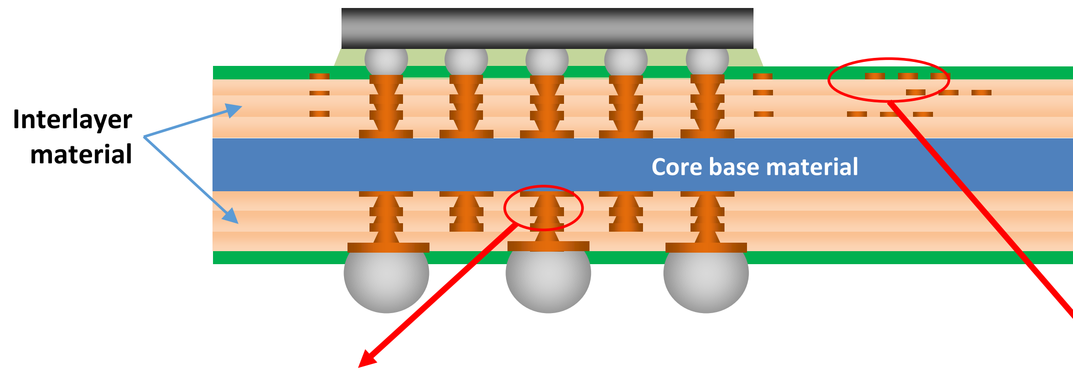
		QV WLI Pro 606
Measuring range	Vision	600 x 650 x 220 mm
	WLI	515 x 650 x 220 mm
Measuring accuracy	E_{1X}, E_{1Y}	0.8+2L/1000 µm
	E_{1Z}	1.5+2L/1000 µm
	E_{2XY}	1.4+3L/1000 µm
WLI repeatability		2σ≦0.08µm

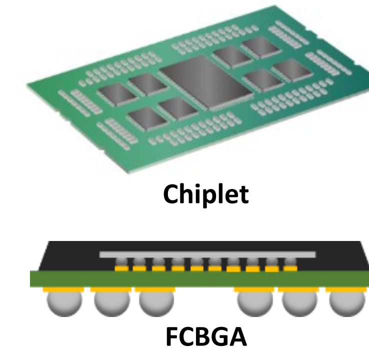
Detection principle of white light interferometer



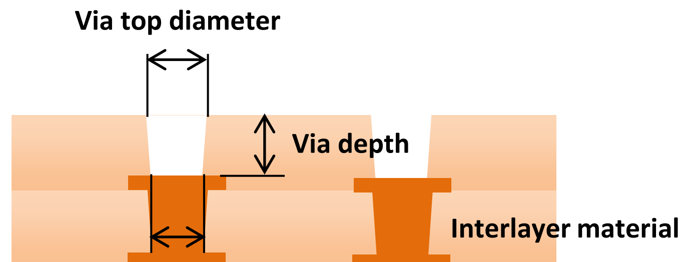
Advanced package substrate measurement application

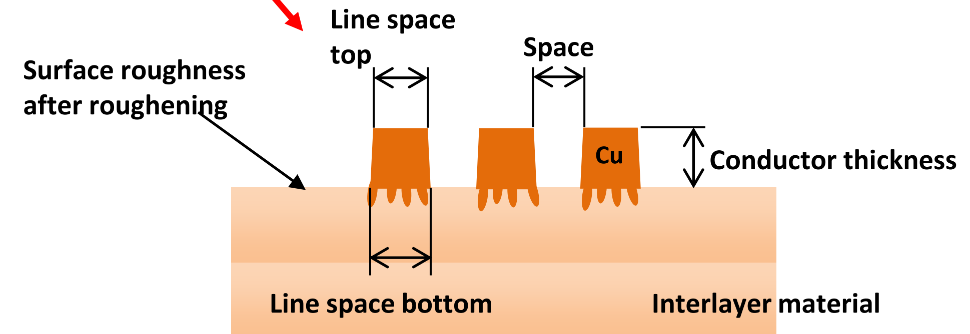
As the performance of semiconductor packages improves, wires become thinner and have higher aspect ratios, making it difficult to detect edges using image processing.
Measurement is achieved by 3D measurement using QV-WLI equipped with white light interferometer WLI.



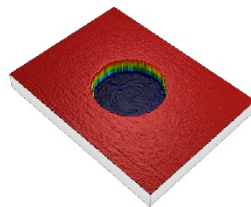


Main measurement items for multilayer boards

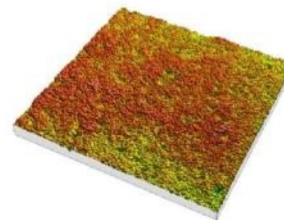




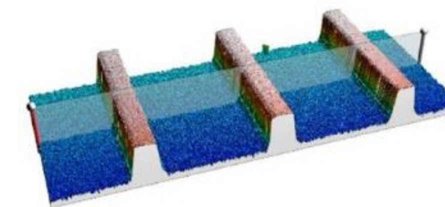
- ✓ Via top & bottom diameter
- ✓ Via depth



- ✓ Surface roughness Ra, Rq



- ✓ Copper wiring top & bottom space
- ✓ Conductor thickness



3D measurement using QV-WLI's white interferometer

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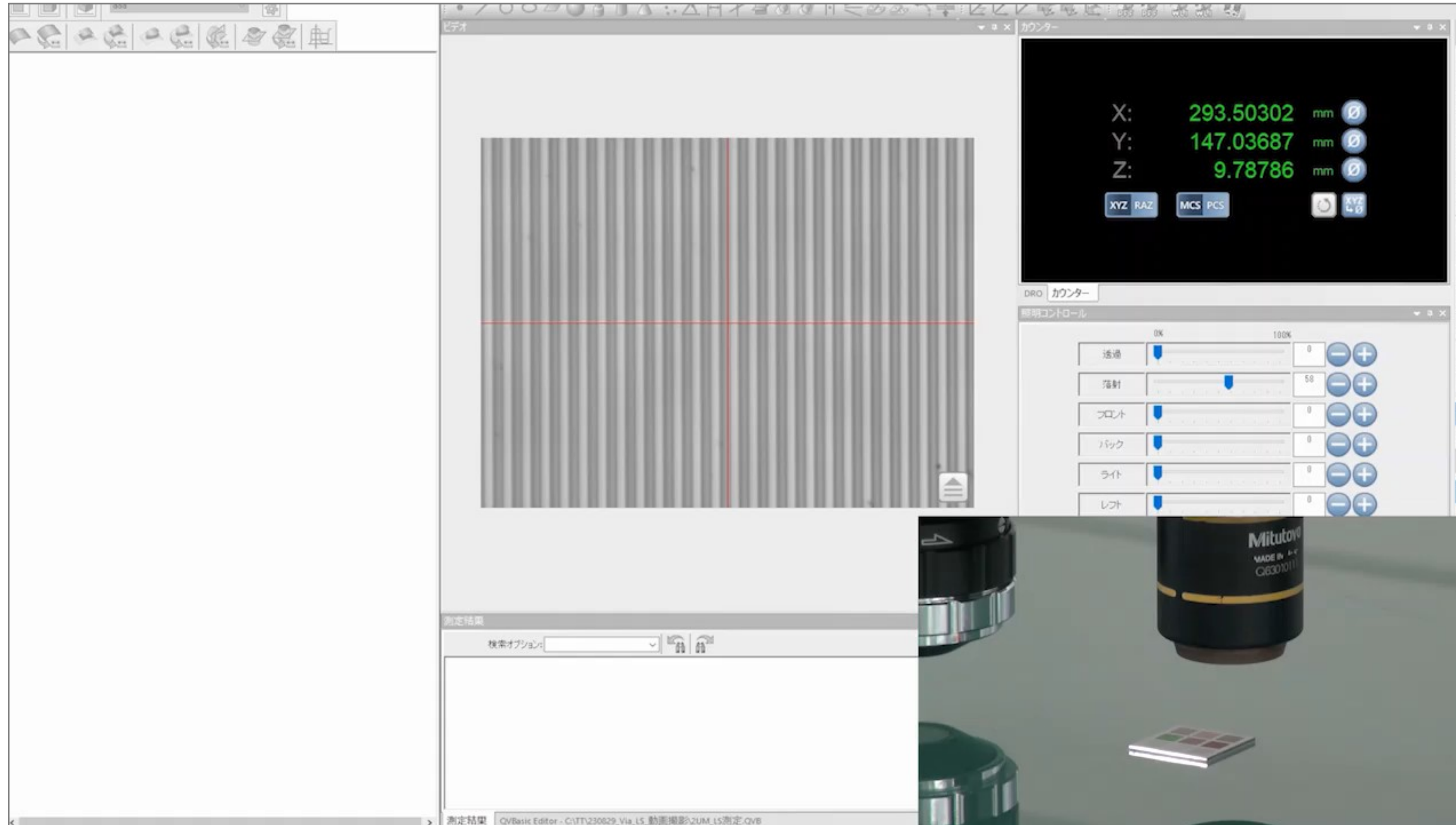
Wiring line & space, conductor thickness measurement



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3D measurement using QV-WLI's white interferometer

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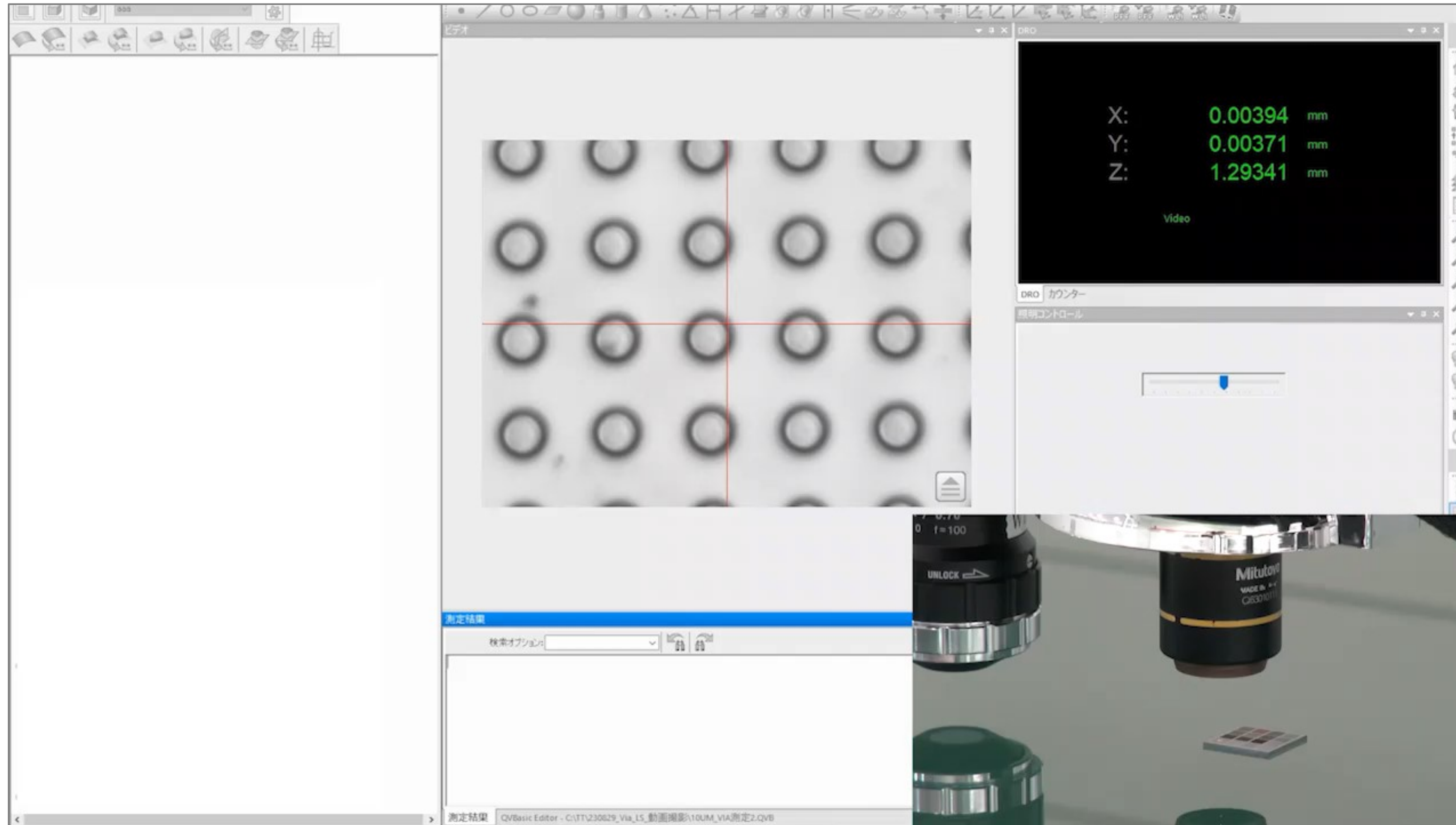
Measurement of Via top diameter, bottom diameter, and Via depth



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Analysis example of TEG HBM using QV-WLI

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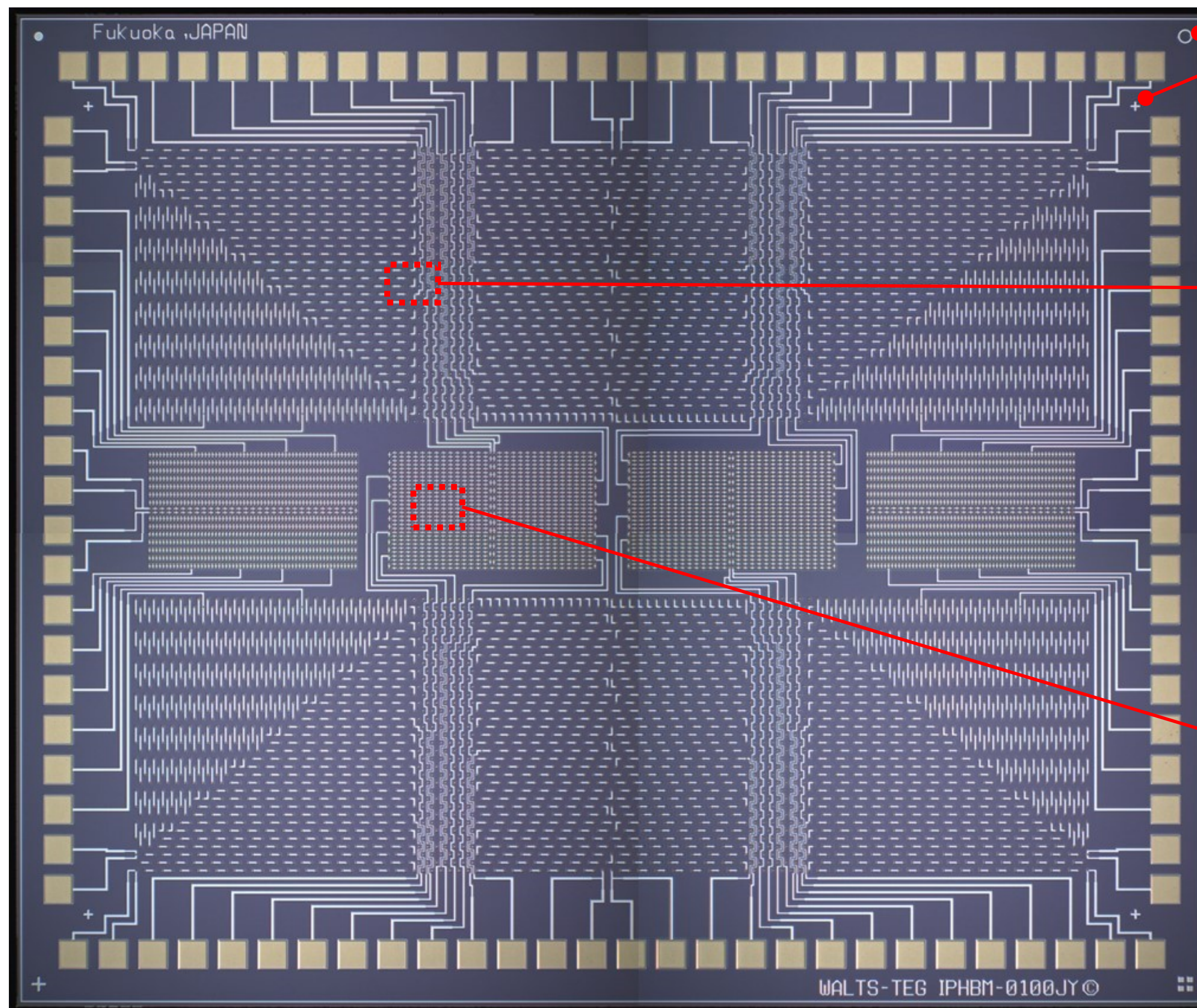
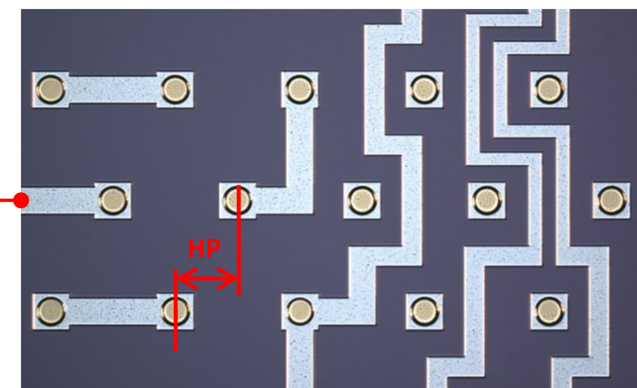
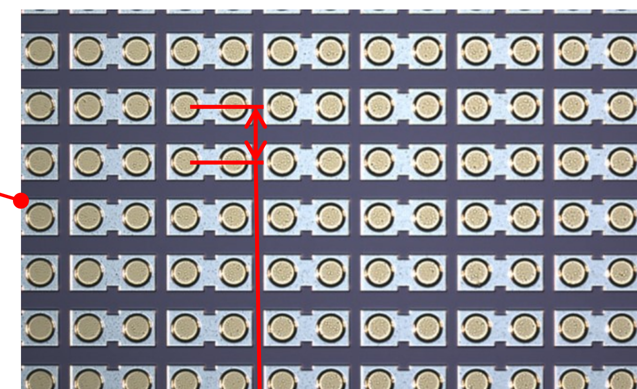
Bump size：ϕ23 μm、H_{Ni}=2.5±1 μm、H_{Au}≦0.1 μm



Alignment mark(four corners)



Staggered・dummy(HPmin= 45 μm)



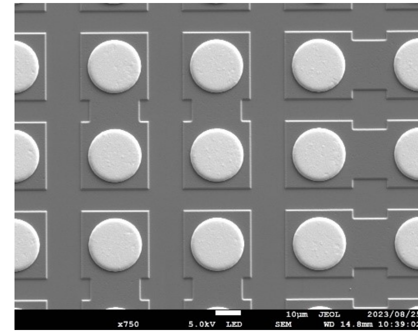
I/O(Pmin= 35 μm)

TEG manufactured company：WALTS CO., LTD.

Analysis example of TEG HBM using QV-WLI

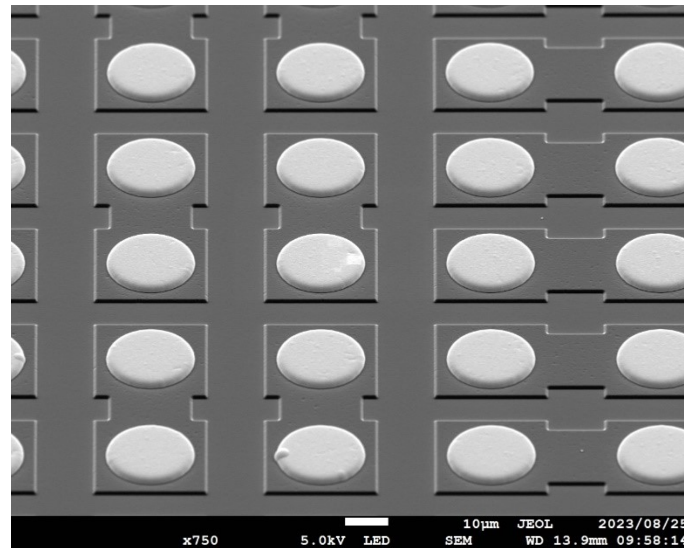
TEG　IPHBM

Microscope vision

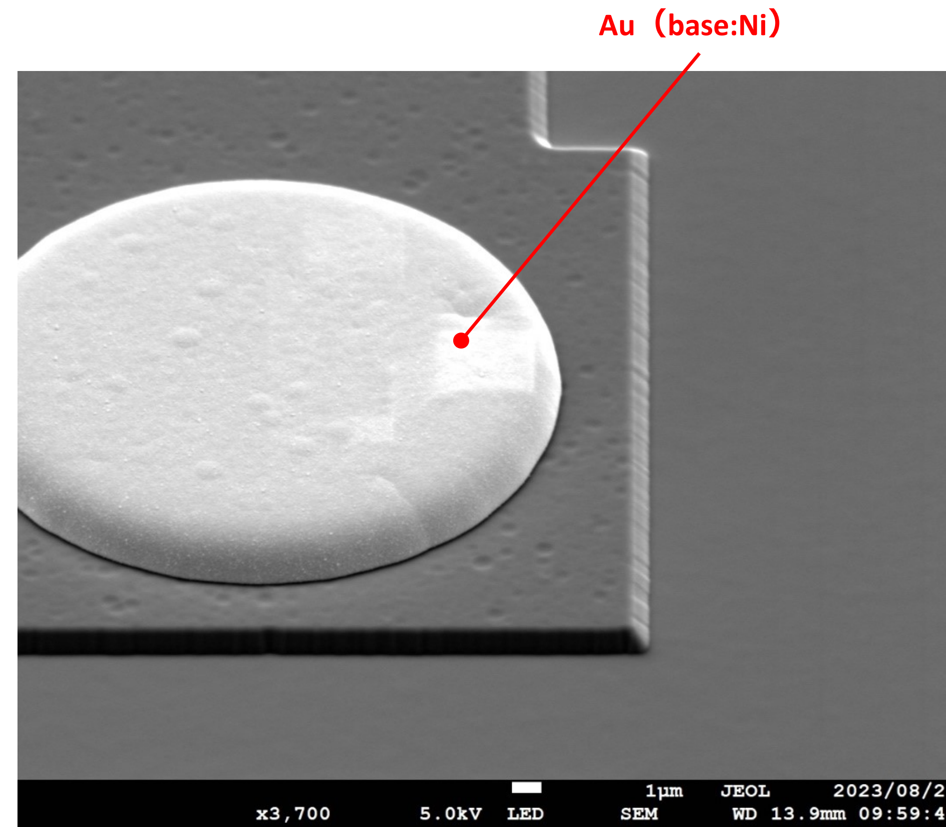


SEM vision

SEM vision



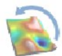
Au（base:Ni）

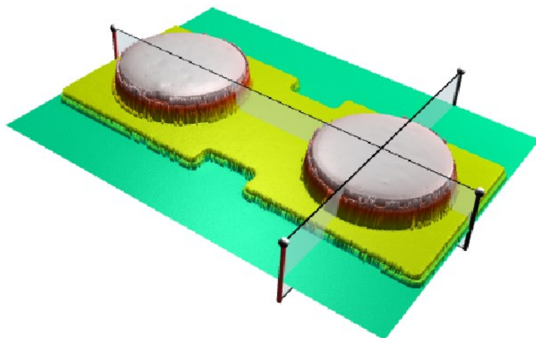


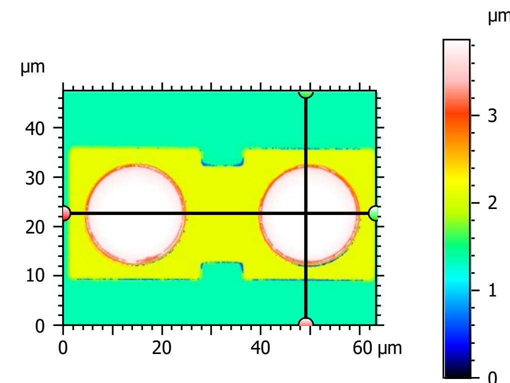
TEG manufactured company：WALTS CO., LTD.

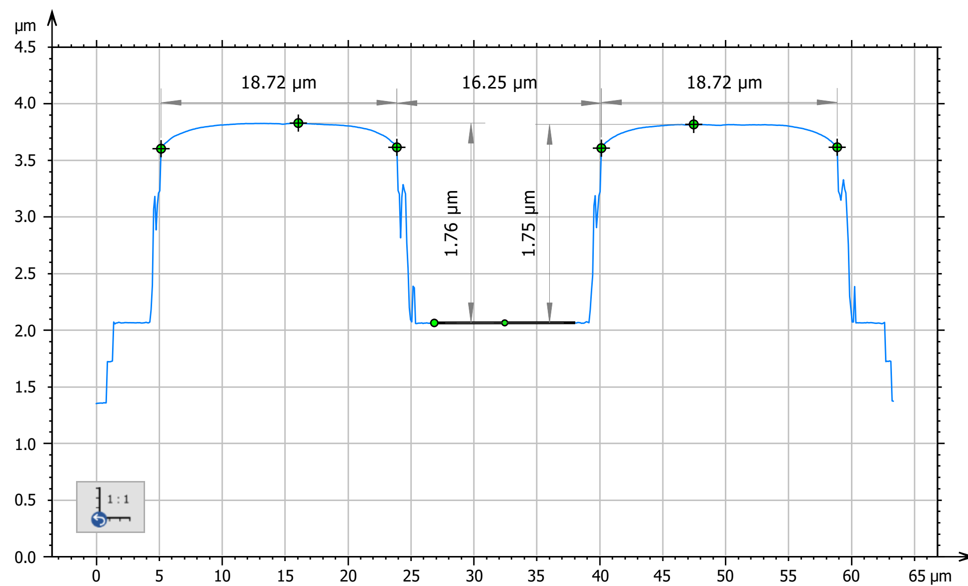
Analysis example of TEG HBM using QV-WLI

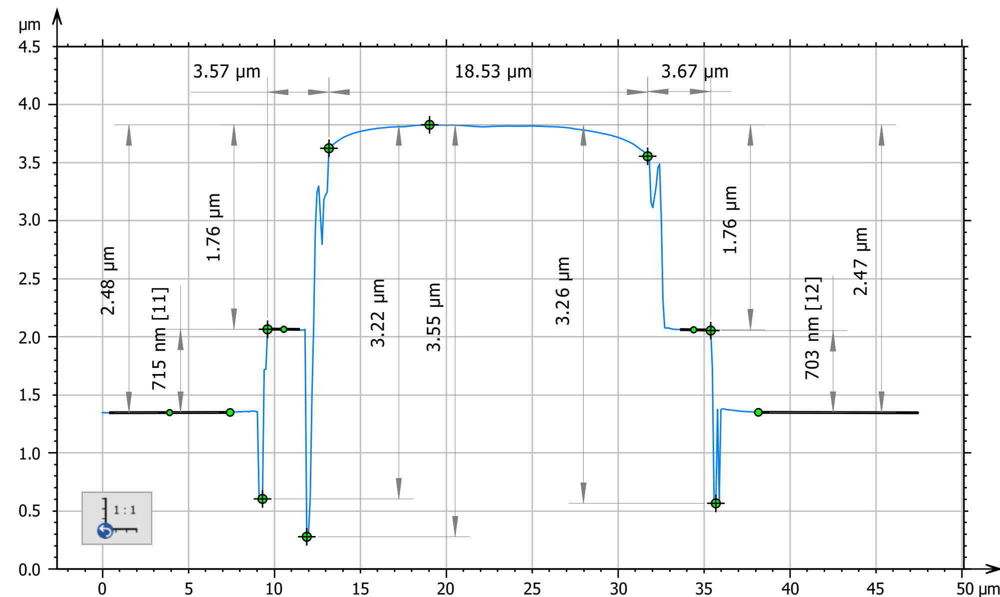
TEG IPHBM







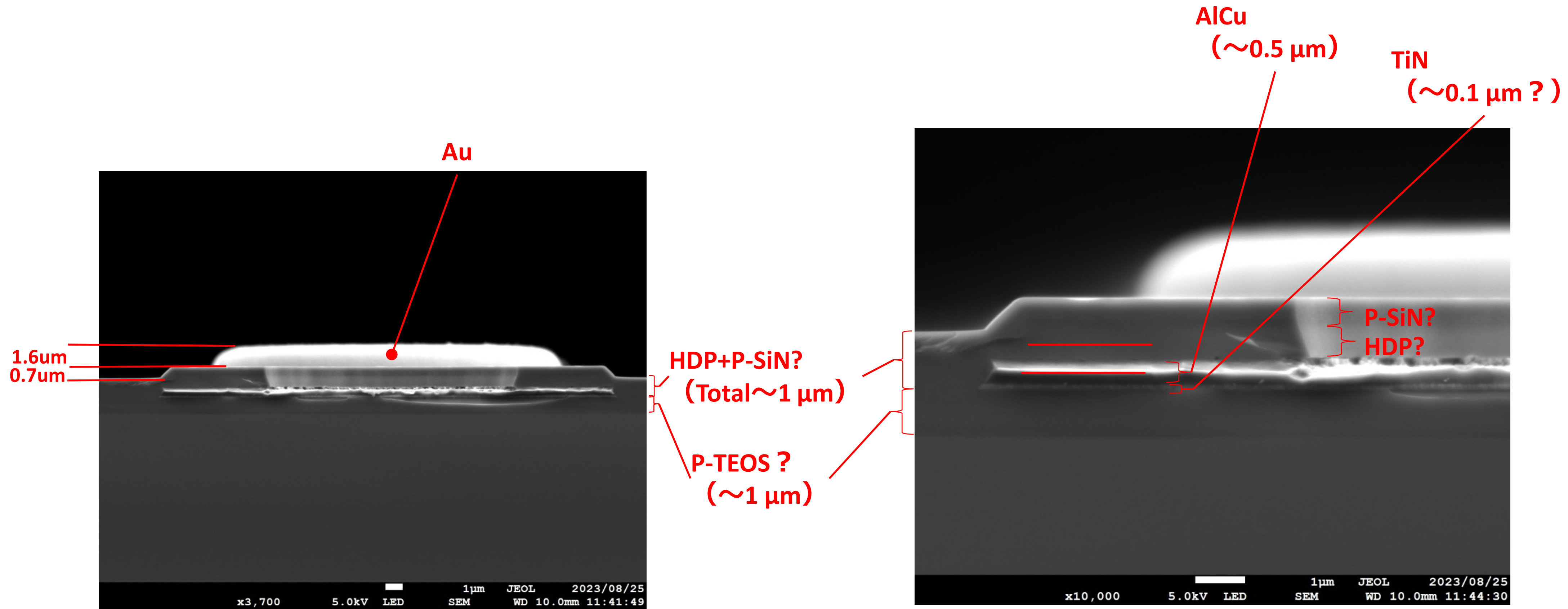




TEG manufactured company：WALTS CO., LTD.

Analysis example of TEG HBM using QV-WLI

TEG IPHBM



TEG manufactured company：WALTS CO., LTD.

Quick Vision equipped with Near-InfraRed light source

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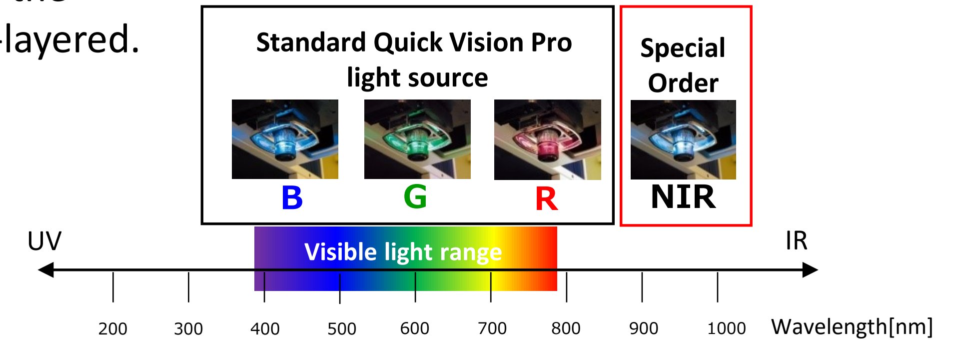
Quick Vision can be equipped with color LED lighting to emphasize edge contrast. Equipped with a near-infrared light source, it will be even more applicable to the measurement of advanced packages, which are becoming increasingly multi-layered.



Main body specifications

		QV HYPER 606
Measuring range		600 x 650 x 250 mm
Measuring accuracy	E_{1X},E_{1Y}	0.8+2L/1000 µm
	E_{1Z}	1.5+2L/1000 µm
	E_{2XY}	1.4+3L/1000 µm
Lighting unit	Contour illumination	White
	Surface illumination	White / NIR
	PRL	White / NIR

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Quick Vision equipped with Near-InfraRed light source

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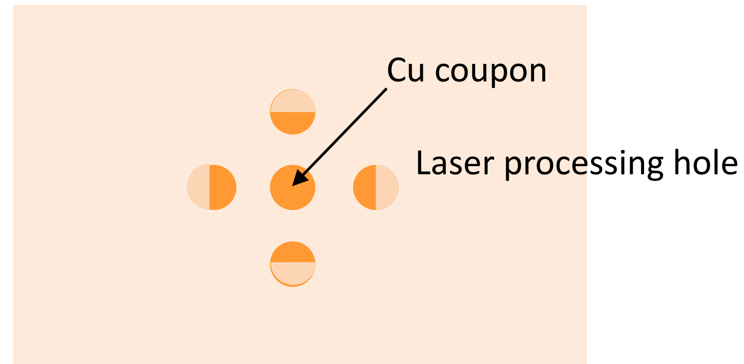
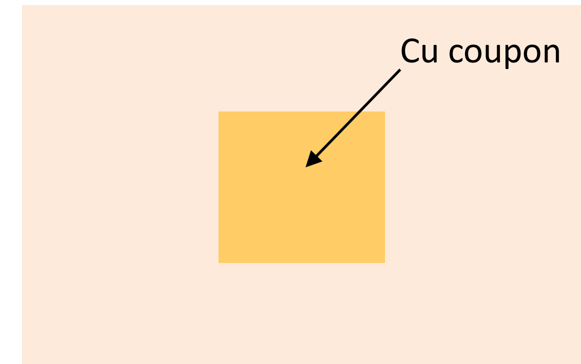
Application examples of models equipped with NIR light sources

It is possible to measure coupons on multi layer PCBs through interlayer materials (ABF, etc.) and SR.
Since laser hole processing is not required, the process can be reduced and there is no need to worry about coupon damage caused by the laser.

Observation overview using visible light



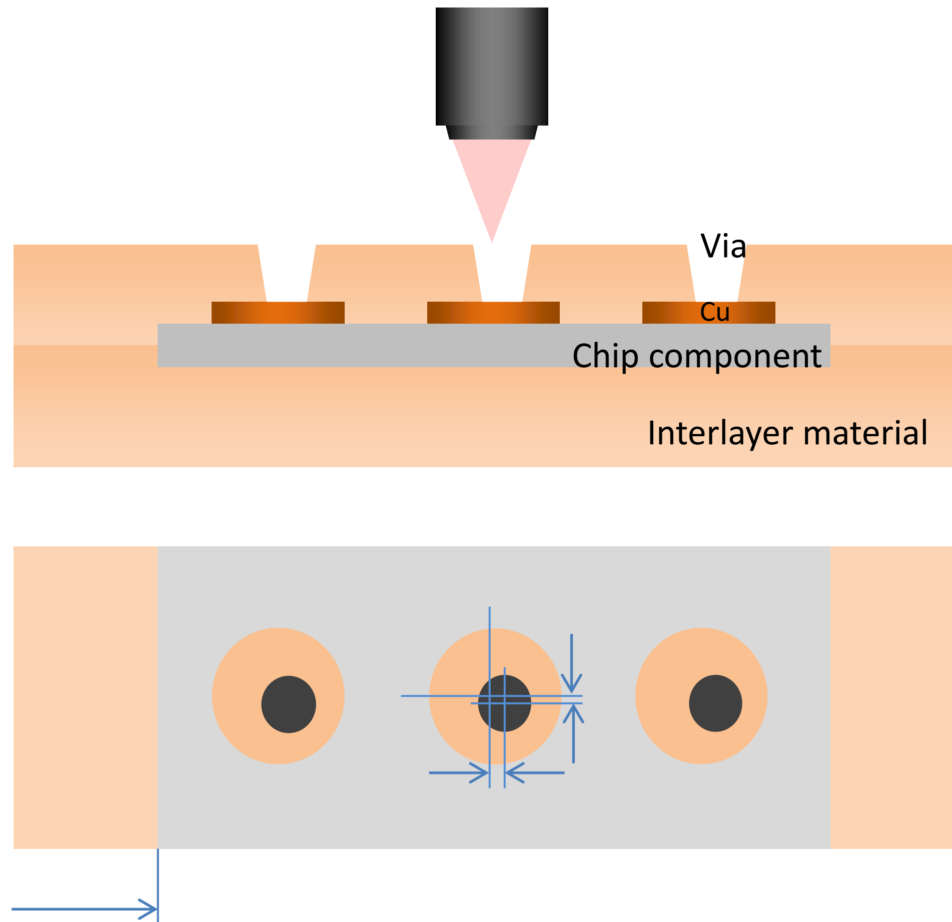
Observation overview using NIR



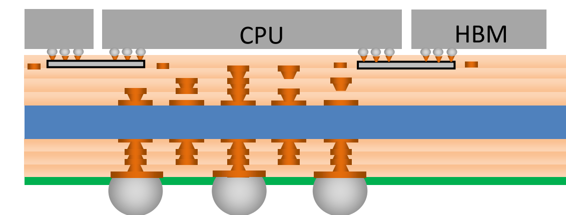
Quick Vision equipped with Near-InfraRed light source

Application examples of models equipped with NIR light sources

It is possible to observe and measure built-in components placed within the interlayer material.



Chiplet pattern diagram



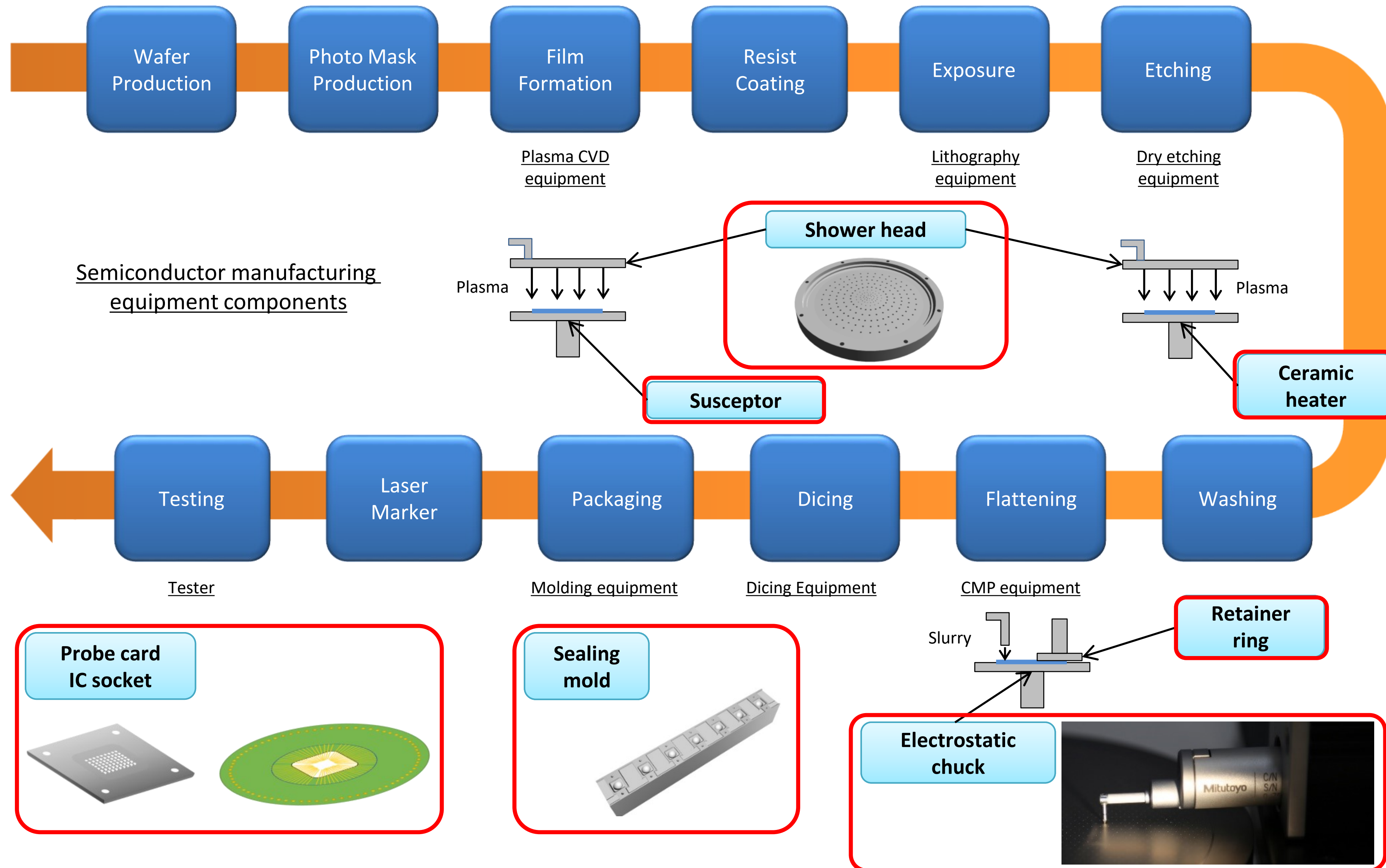
Trends of vision measuring machine

⇒ Compatible with smart factories

MeasurLink

Status Monitor

Semiconductor manufacturing process & Measurement proposal for semiconductor manufacturing equipment parts



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Any questions?

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Thank you

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