

COMPASS

a **FormFactor** users' group conference

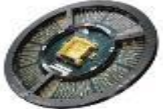
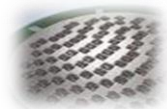
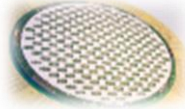
Fine Pitch 20um MEMS Probe

Yoichi Funatoko, Sr. Staff Product Engineer
FormFactor

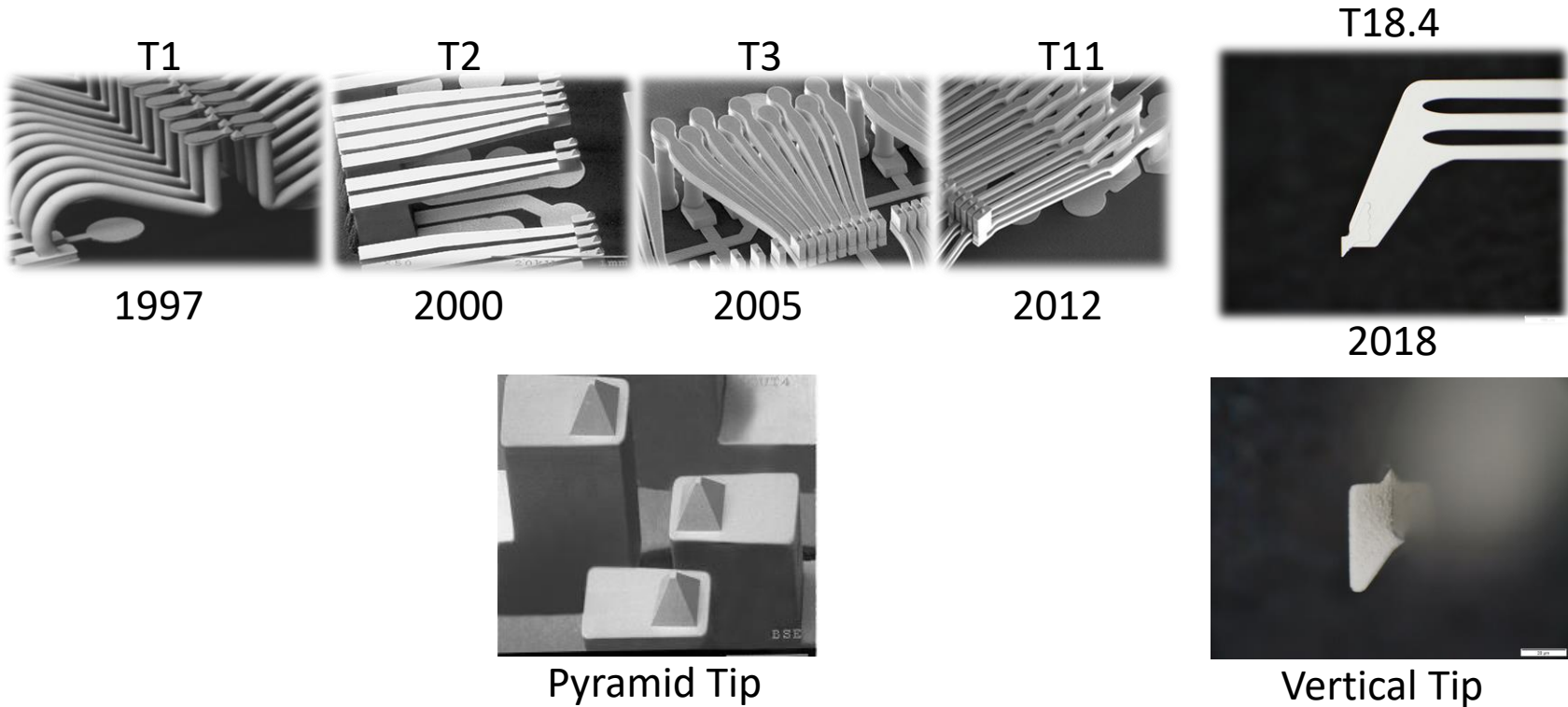
Agenda

1. *MEMS Probe and LED/VCSEL Probe Card Introduction*
2. *Fine Pitch 20um 2D MEMS T18.4 Probe Development*
3. *T18.4 Probe Evaluation*
4. *4 Wire Kelvin Contact Resistance Measurement*
5. *Conclusion*

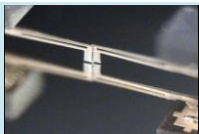
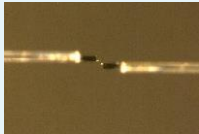
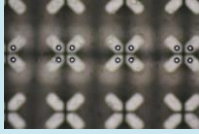
Probe Card Product Portfolio

<i>Parametric</i>	<i>RF</i>	<i>SoC WLCSP</i>	<i>SoC Grid Array</i>	<i>SoC Optical IC</i>	<i>SoC Wire Bond</i>	<i>DRAM</i>	<i>FLASH</i>
 Takumi	 Pyramid	 Qilin	 Apollo	 Hikari for Image Sensor	 TrueScale	 SmartMatrix	 TouchMatrix
 Pyramid	 Katana-RF	 Katana	 Vx	 Akari for LED / VCSEL	 PH	 HFTAP	 Vector
 Cantilever					 Katana	 PH	 PH

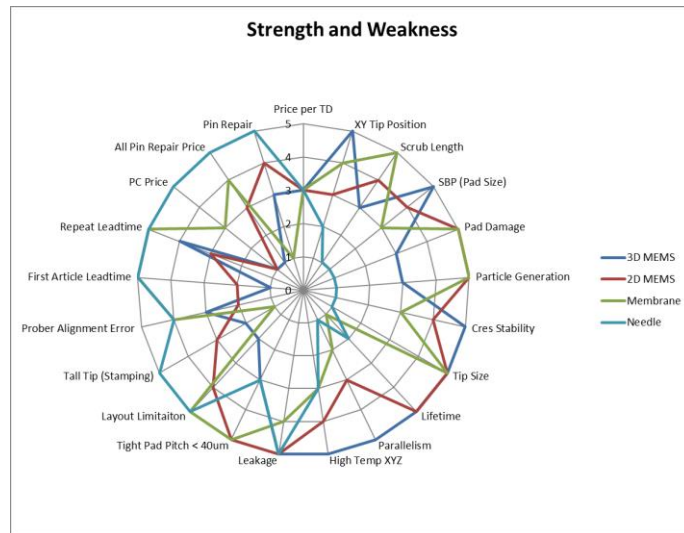
New 2D MEMS Spring Tip Design for 20um Pitch



Probe Type Advantage and Disadvantage

Option	Probe Type
1 	3D MEMS Cantilever
2 	2D MEMS Cantilever
3 	Membrane RBI
4 	Needle

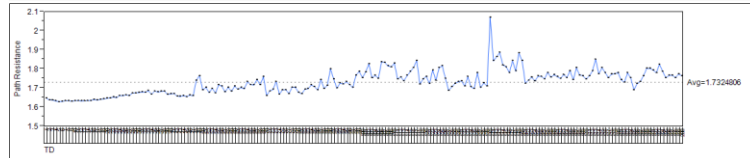
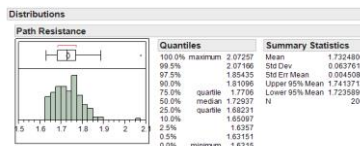
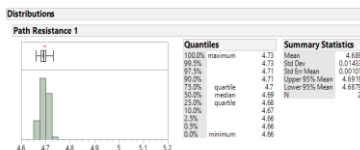
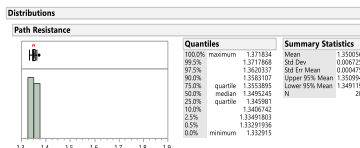
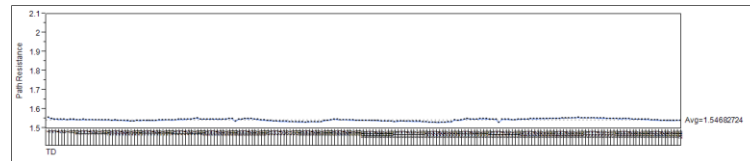
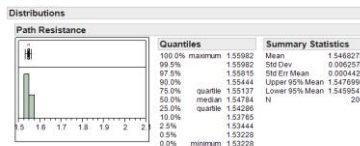
Advantage / Disadvantage



There is no perfect probe.

2 Pin Path Resistance on Gold Wafer 200TD

Option	Probe Type	Resistance Standard Deviation (Ohm)
1	3D MEMS Cantilever	0.006
2	2D MEMS Cantilever	0.007
3	Membrane RBI	0.014
4	Needle	0.064



20um Pitch New Spring Development

Customer Requirement

- Fine Pitch < 20um Target
- Bump Size < 10um
- Optical Test Clearance



FormFactor Japan

- Initial Design Concept
- Ceramic Design
- Probe Attachment Tool

Yokohama



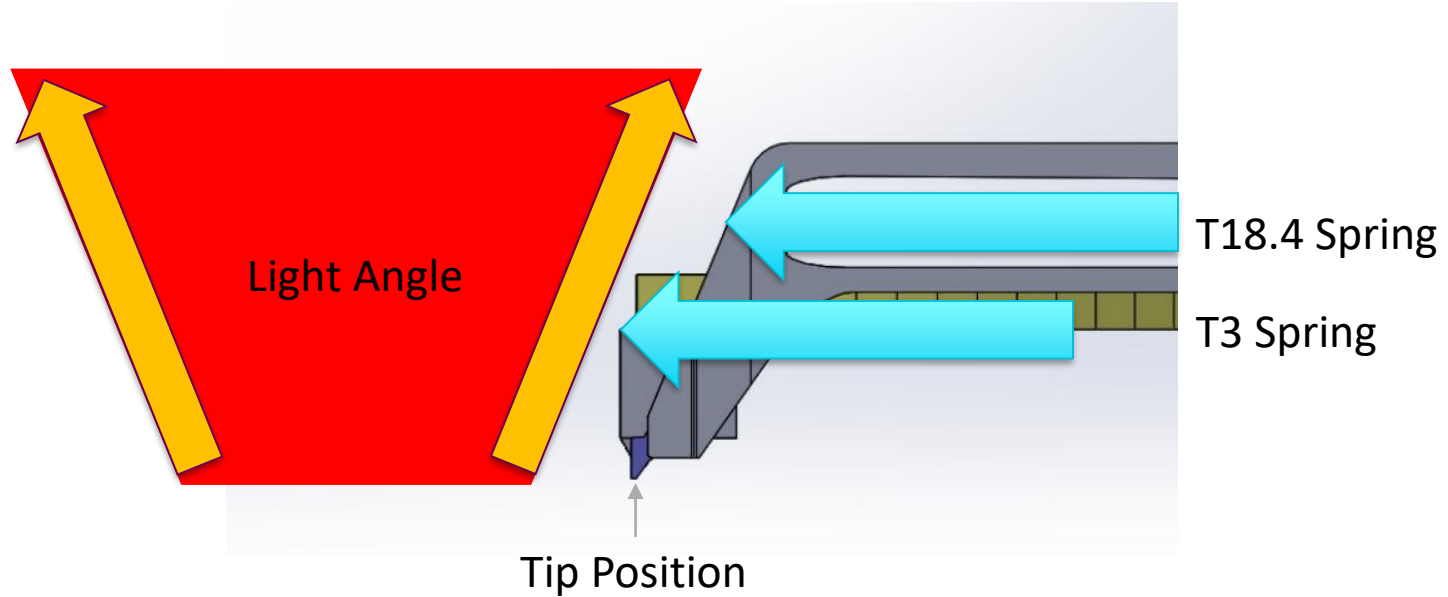
FormFactor USA

- MEMS Spring Design
- MEMS Wafer Manufacturing

T18.4



Optical Test Clearance



3D MEMS Probe to Tip Alignment by Top Camera

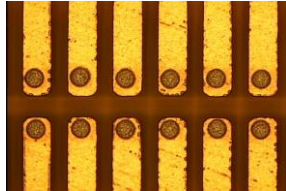
Prober

- No Upper Looking Chuck Camera

3D MEMS Cantilever Probe

- Can not see Probe Tip Position from Top Side
- Beam Top Laser Mark XY Position Accuracy $\pm 5\mu\text{m}$

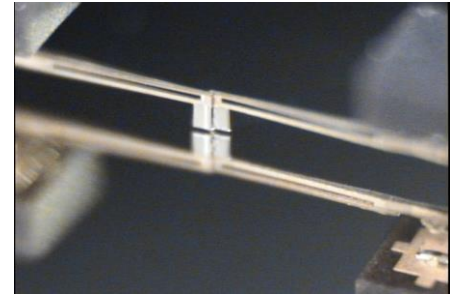
Laser Mark on Beam



Top View



Side View



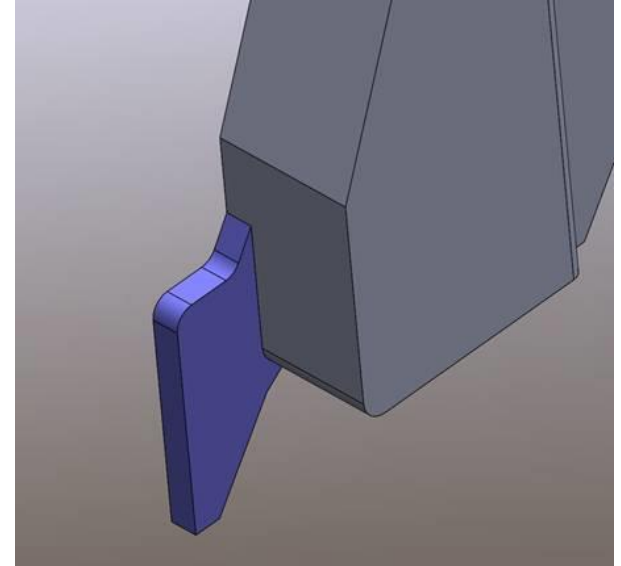
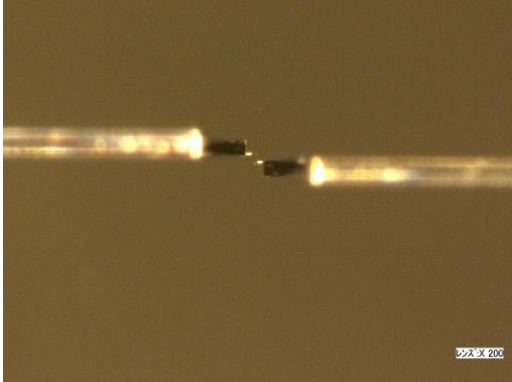
New 2D MEMS Probe Alignment from Top Camera

Prober

- No Upper Looking Chuck Camera

New 2D MEMS Cantilever Probe

- Probe XY Tip Position Visible from Top Side

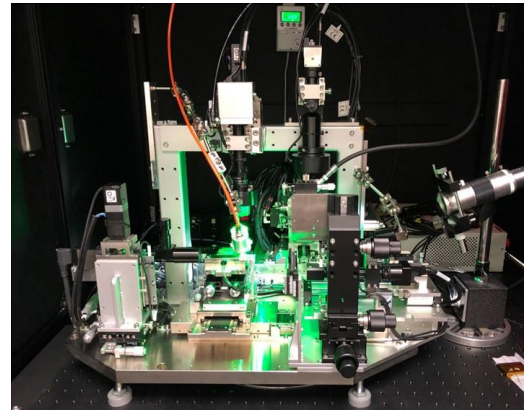
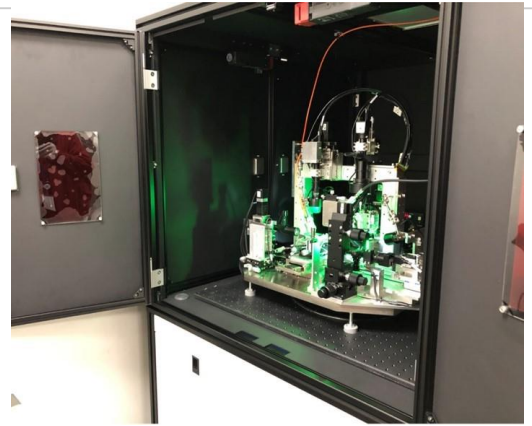


Mirai Machine

Single Pin Attach System

Feature

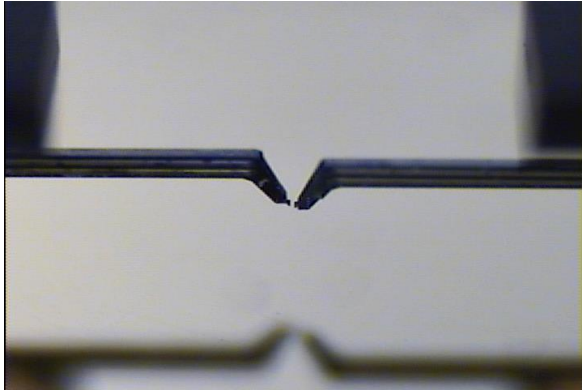
- 2D and 3D MEMS Spring Attach System
- Development at Yokohama, Japan
- Solder Paste Bonding
- Component Unit
 - Spring Pick and Place
 - Substrate under PH50
 - Optical Unit Tip Alignment
 - Solder Paste Heating System
 - Solder Paste Supply Unit
 - Original Control Software



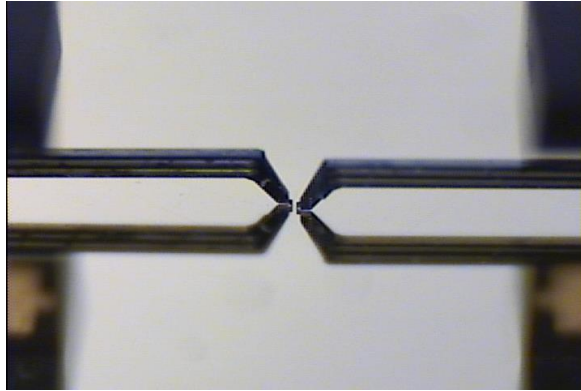
T18.4 Spring Over Drive Operating Margin

Same Spring From Lab to Fab

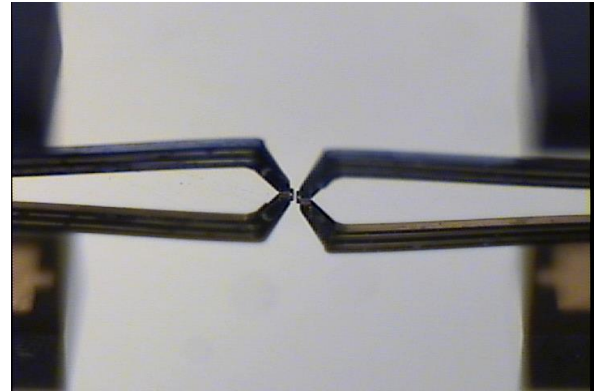
- Max OD = 100um
- Flexible Beam Structure
- Wide Range of OD Operating Margin



Before Contact



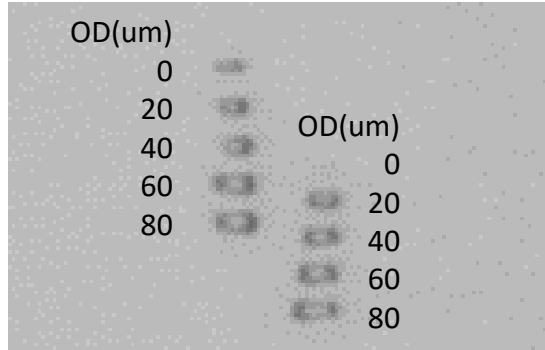
OD = 0um



OD = 100um

T18.4 Scrub Ratio on Gold Wafer

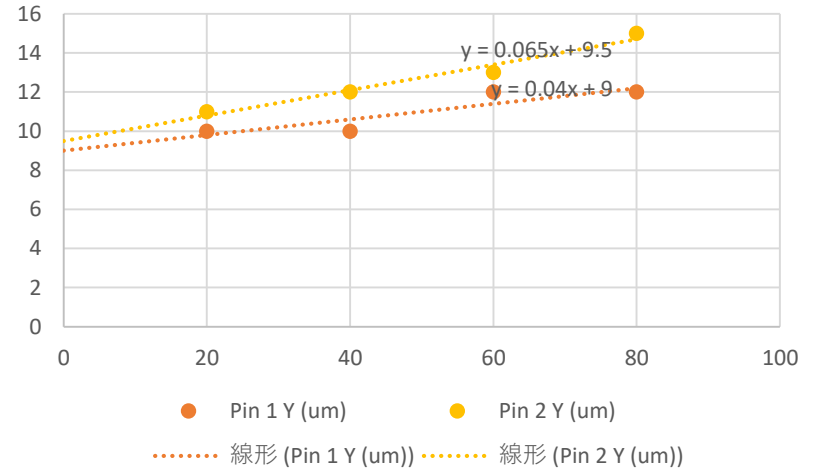
Scrub Ratio = 4 to 6.5 %



OD (um)	Pin 1 Scrub Size		Pin 2 Scrub Size	
	Y (um)	X (um)	Y (um)	X (um)
0				
20	5	10	6	11
40	6	10	6	12
60	6	12	6	13
80	6	12	6	15

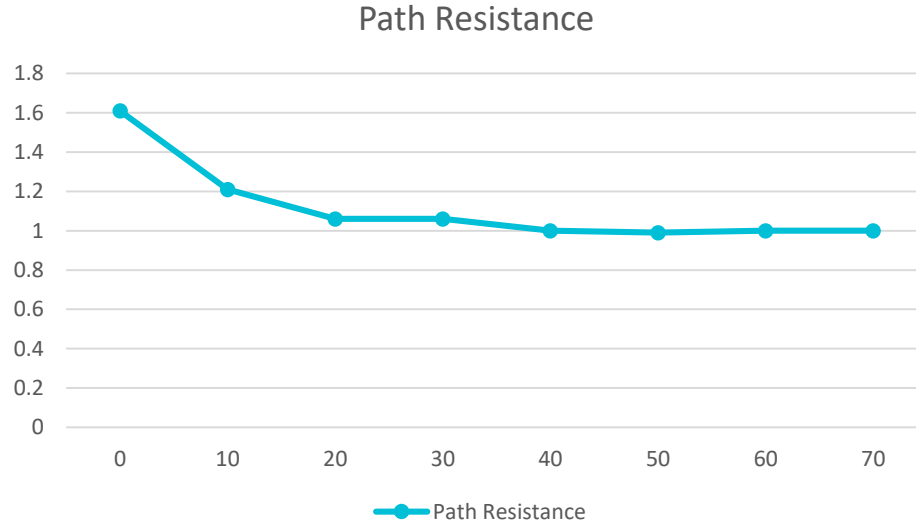
First Electrical Contact

T18.4 Scrub Size (um) vs OD



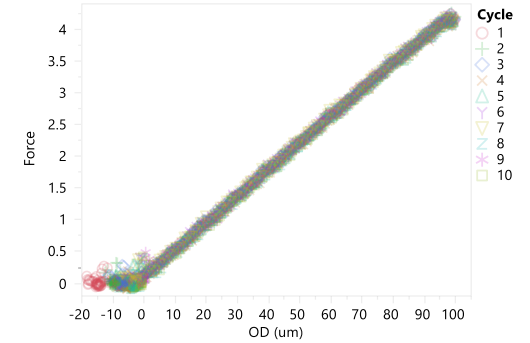
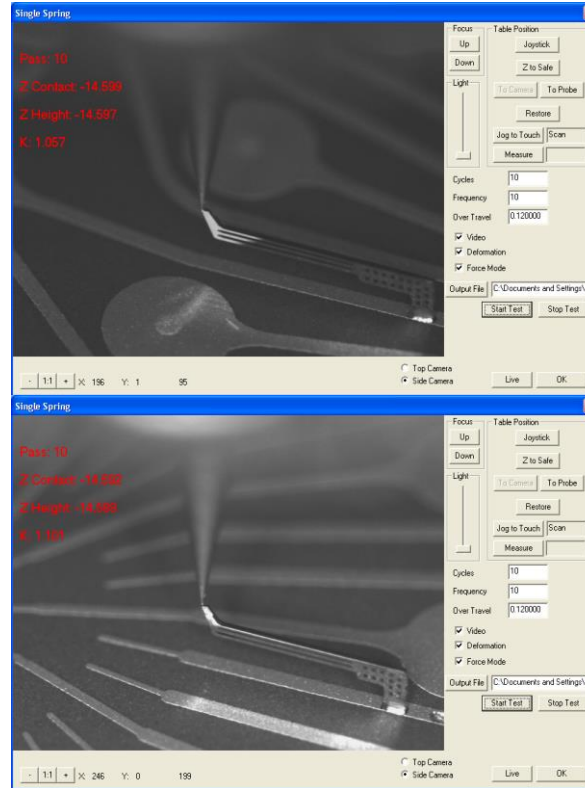
T18.4 Spring 2 Pin Path Resistance vs OD(μm)

Path Resistance is stable after OD = 20 μm on Gold Wafer

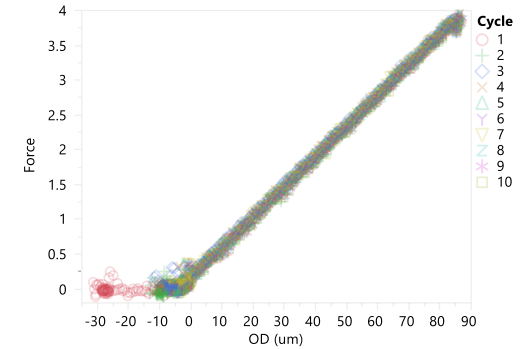


T18.4 Spring K-Value Measurement Result

Long Beam : 1.057g/mil



Short Beam : 1.101g/mil

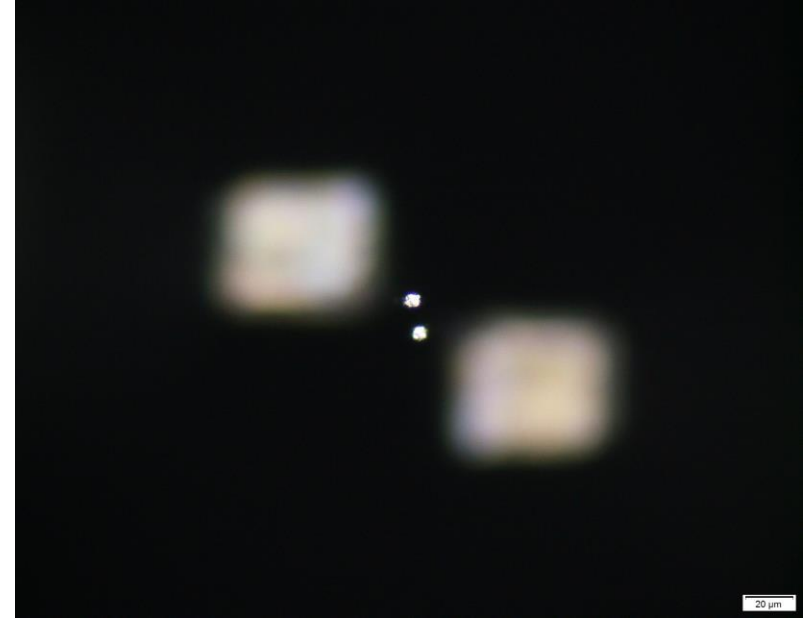


13um Pitch Probe Card for Micro LED

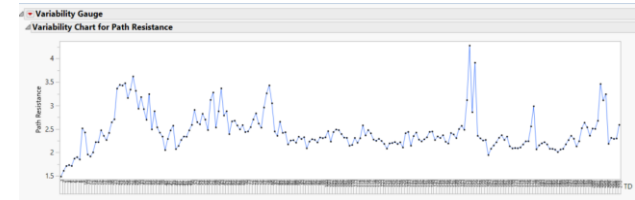
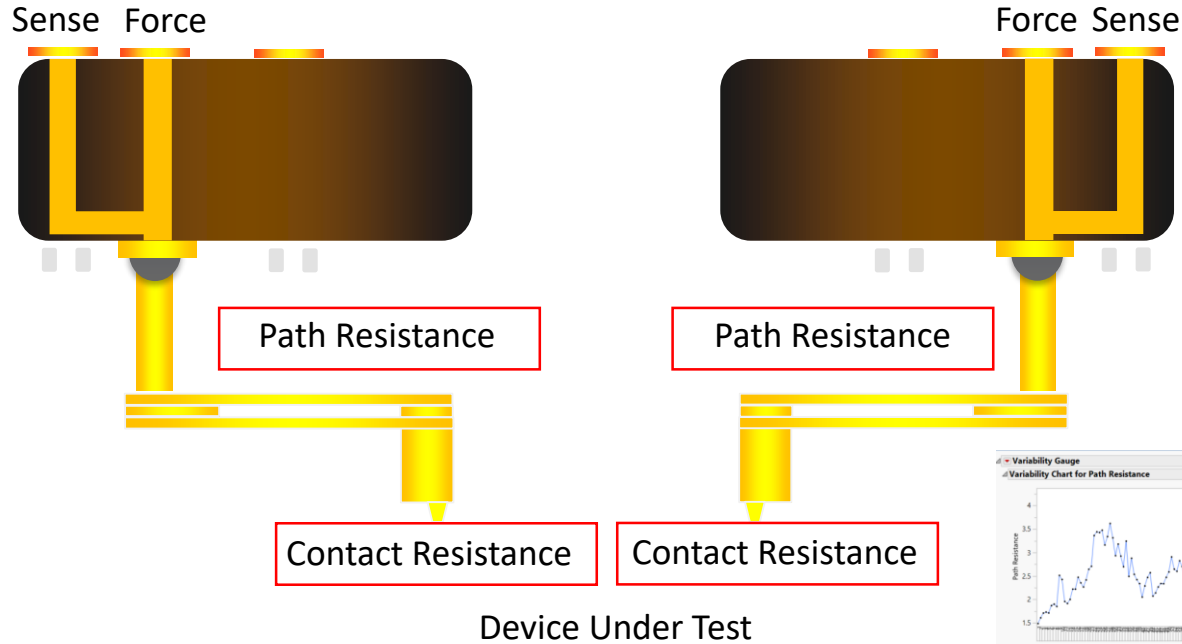
Probe Attached by Mirai Machine

- XYZ Error +/-1um

No.	Tip Location Error (um)					
	X Target	Y Target	X	Y	Z	
1	1	1	13	1	0	-1
2	-1	-1	0	-1	0	0



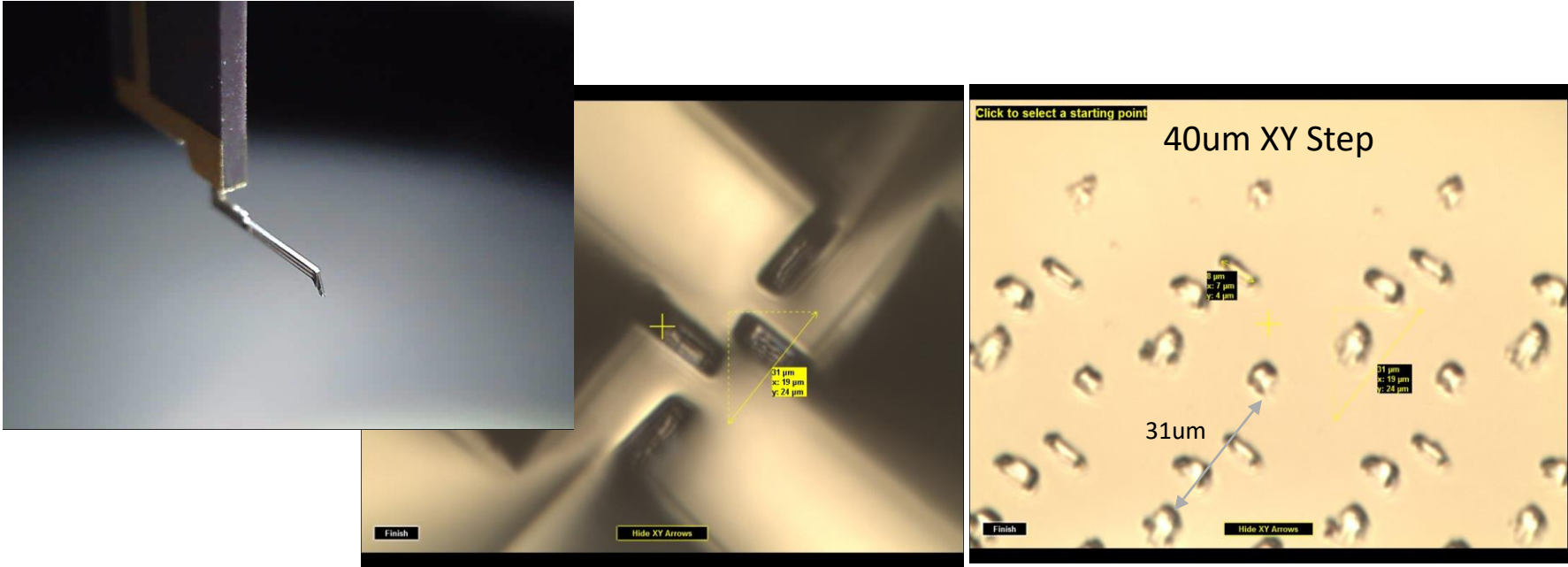
Probe Card Path Resistance and Contact Resistance Creates Measurement Error by 2 Wire Resistance Measurement Method



4 Wire Resistance Measurement by Positioner

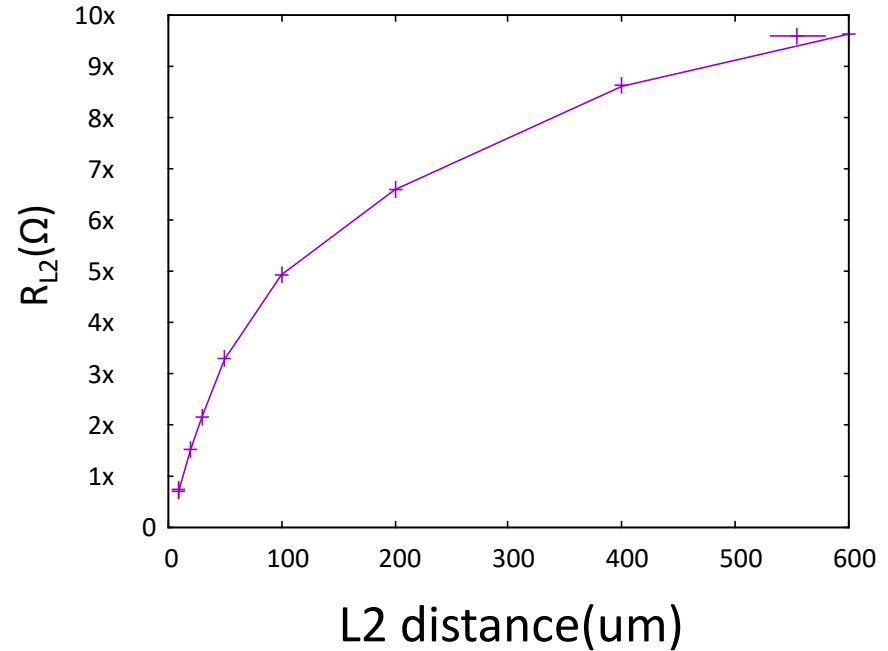
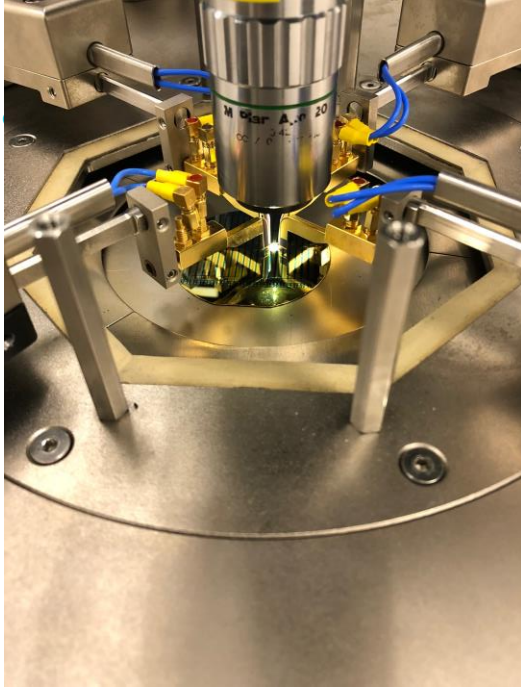
T18.4 Probe Ceramic Blade

- Mechanically Compatible with High-Performance DC Parametric Probe Holder



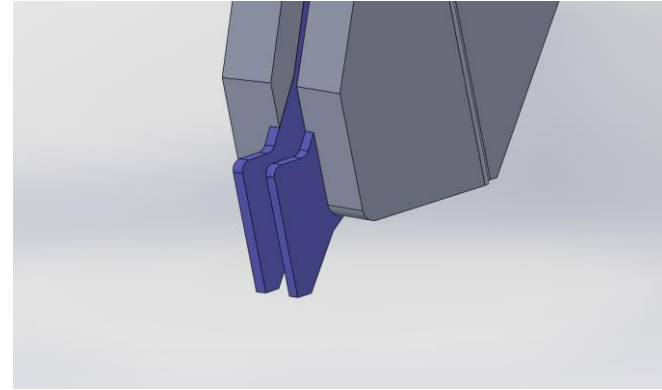
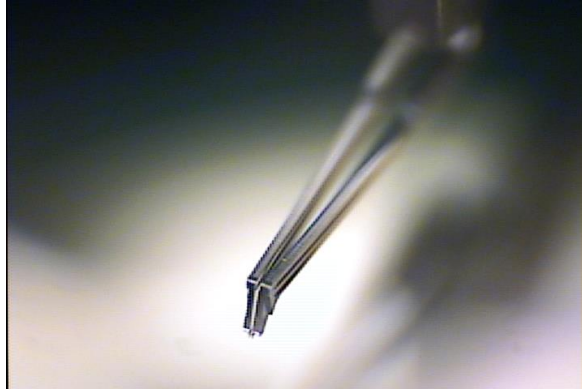
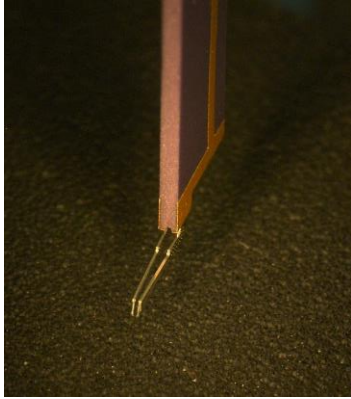
Wafer Surface Resistance Measurement by Distance

4 Wire Mode Resistance Measurement on Summit 12000 Prober



Ceramic Blade 20um Pitch Kelvin Probe

Mechanically Compatible with High-Performance DC Parametric Probe Holder



Conclusion

T18.4 2D MEMS Probe Developed for Minimum 20um Pitch

Completed Initial Probe Evaluation

Micro LED Probe Card and Kelvin Probe Head for 4 Wire Resistance Measurement

Thank You!

For questions, please contact:

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