SW Test Workshop
Semiconductor Wafer Test Workshop

Probing for WLP Evaluation

Clark Liu

Chip Probe Operations Division
Powertech Technology Inc.

June 5-8, 2016

Overview

- **Background**
- **For WLP Probing Evaluation**

  Make a Test Vehicle to validate and choose Right Product.

  Quickly Feedback to Suppliers for CIP.

  (1)CPB Test Vehicle

  (2)RDL Test Vehicle

  (3)WLCSP Memory High Parallel Probe card
- **Future Work for the WLP Probing solutions**
- **Conclusions**

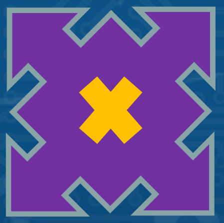
New Requirement from User and Supplier Side?

User

1.R&D Team **get Request** to meet the New WLP Technology Requirement

2.R&D Team **Looking for suitable** Supplier Product meet the target

3.MFG Team consider the **Schedule /Cost/Production /Performance issues**



Supplier

1.Sales team Buildup the New Business **to meet customer Requirement**

2.Marketing/R&D team Understand and **Make Solution meet customer criterion**

3.MFG Team Buildup the product meet the **Spec**

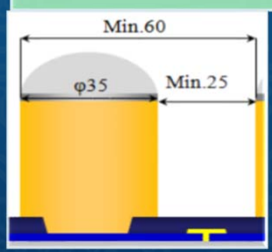
Choose from User and Supplier Side?

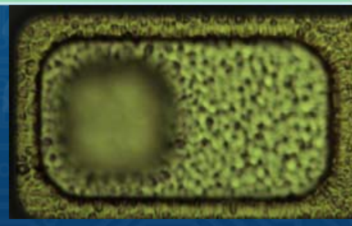
User

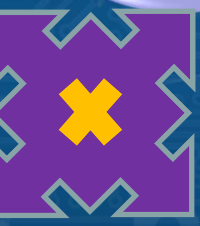
1)Consider **Production Yield Performance/Cost/Schedule**

(2)Consider **Supplier Product meet the New Technology Product**

(3) **Which is the best solution**



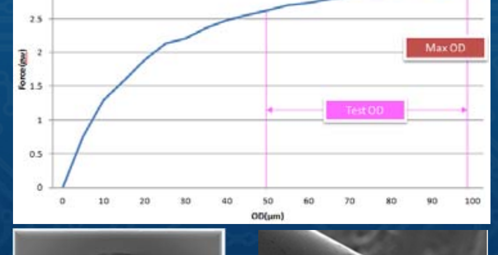


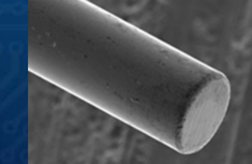


Gap？

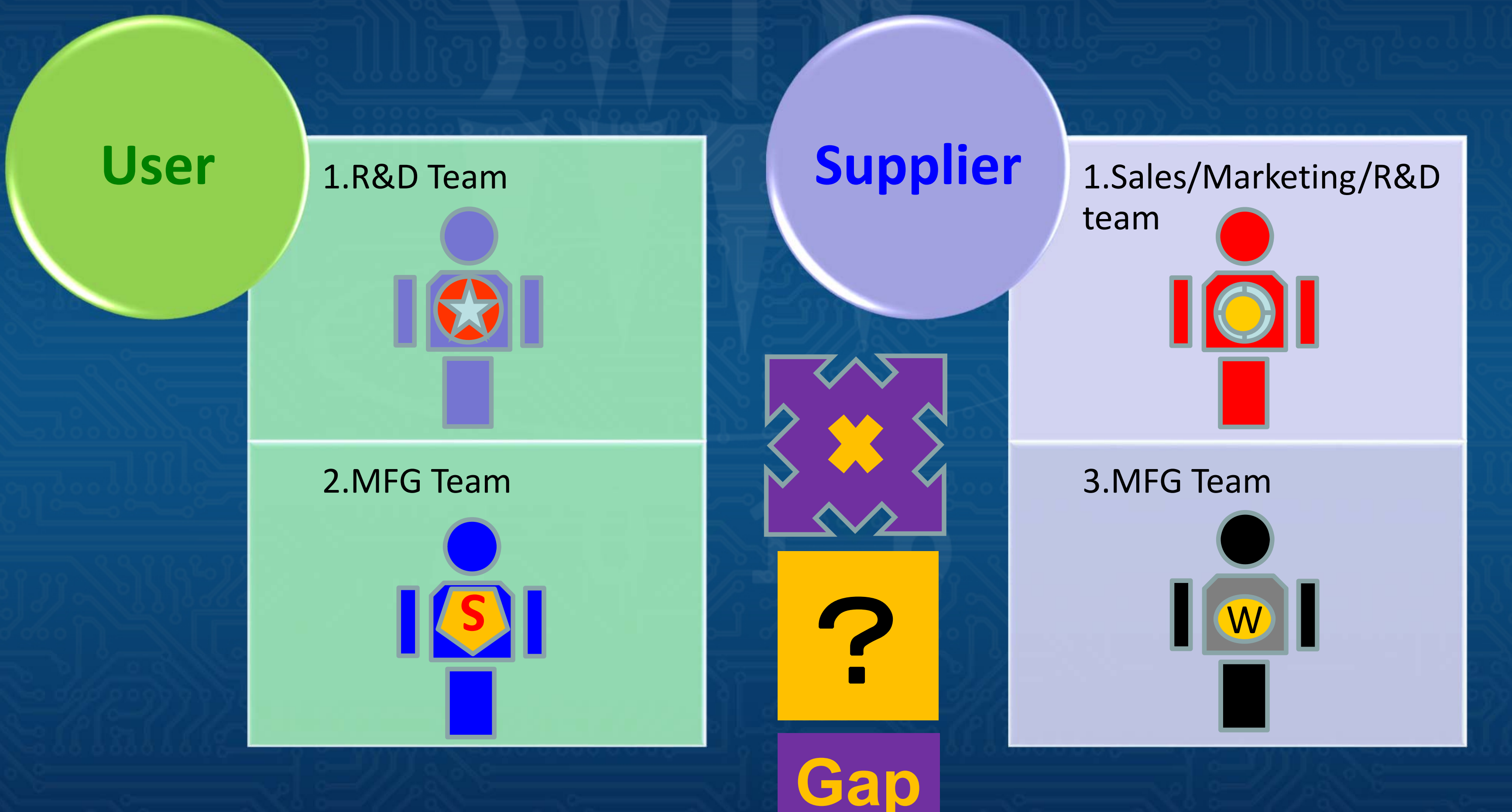
Supplier

Alignment	± 0.3 mil
Planarity	± 0.3 mil
Leakage	I/O:10 nA@10 V Power/Ground: 20 nA@10 V
Tip Diameter (tolerance)	± 3 um
Tip Shape	Flat
1st Layer Tip Length	10+/-1 mils
Max. OD (from first contact)	60um
Max. Current	200 mA
Temperature Range	-40~125℃

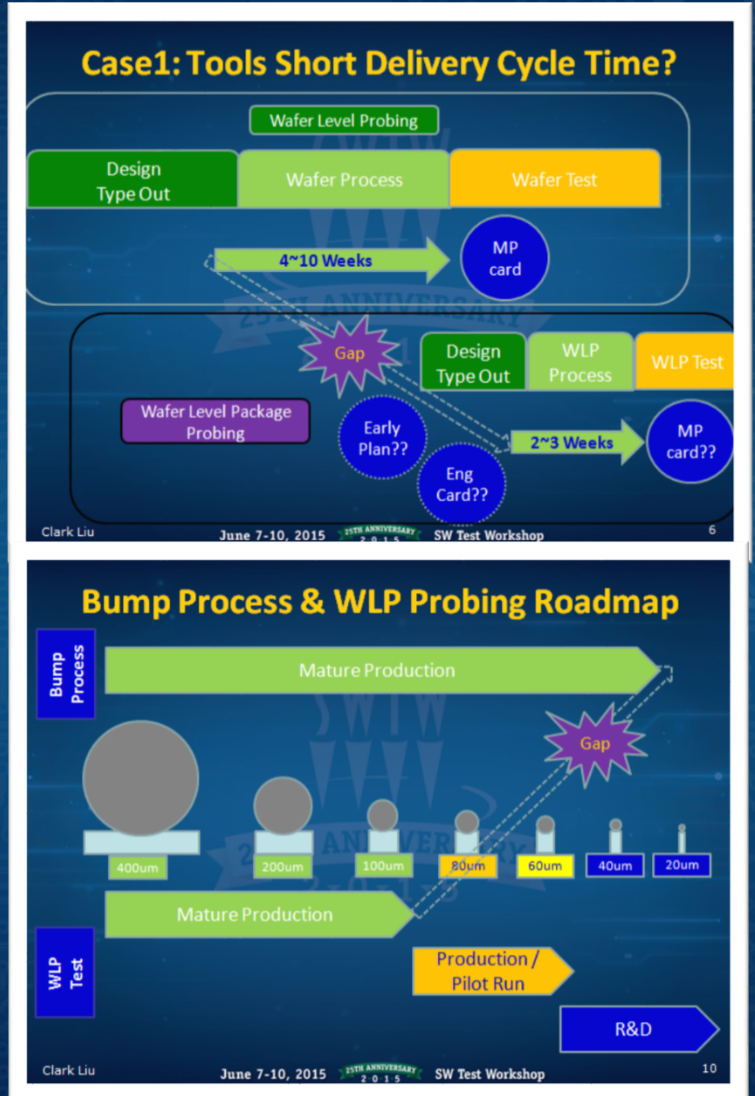


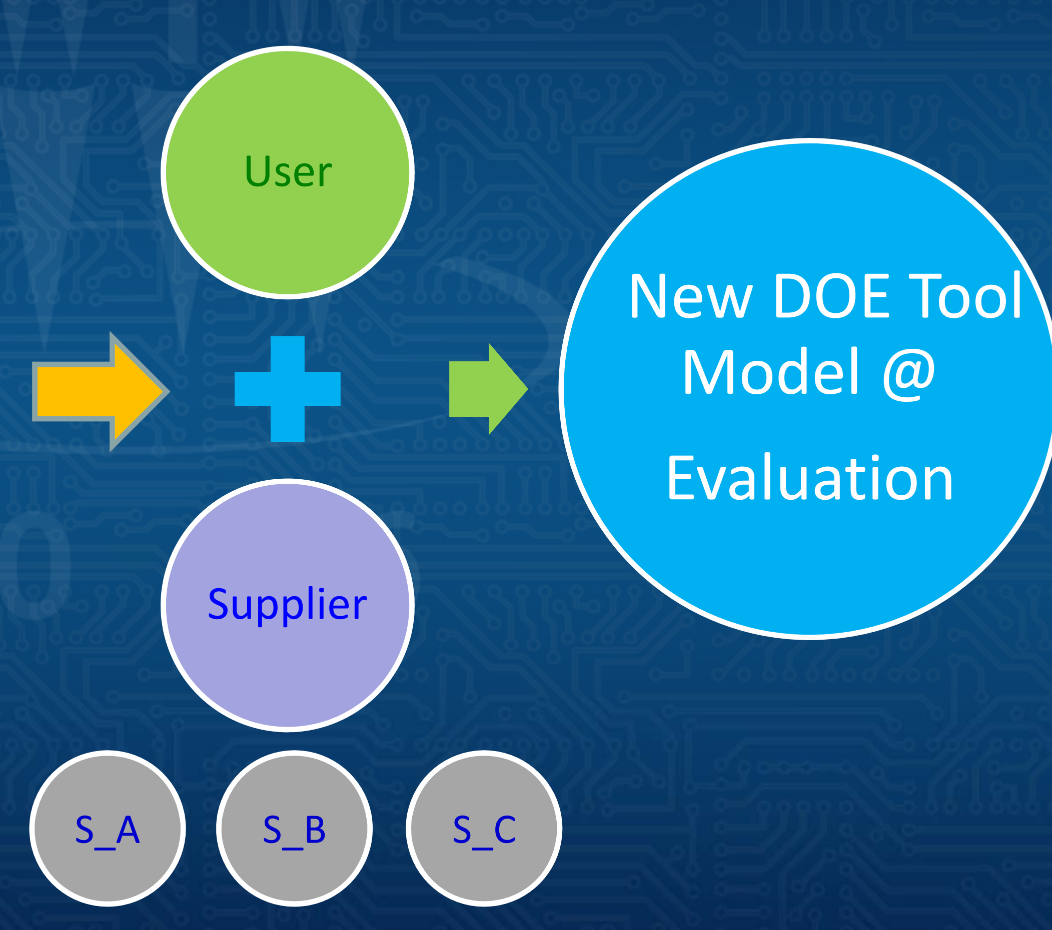


Working from User and Supplier Side?



Idea for WLP Probing Evaluation



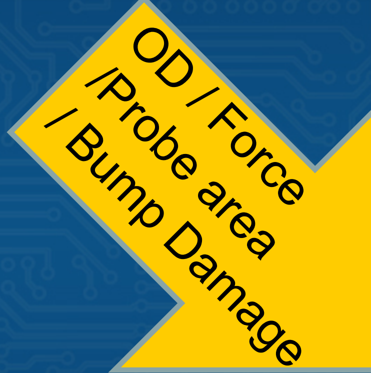


DOE Tool @ WLP Probing Evaluation

DOE Tool
Model
Evaluation

Probing
Position / Depth
/ Damage

Different
Contact
Position



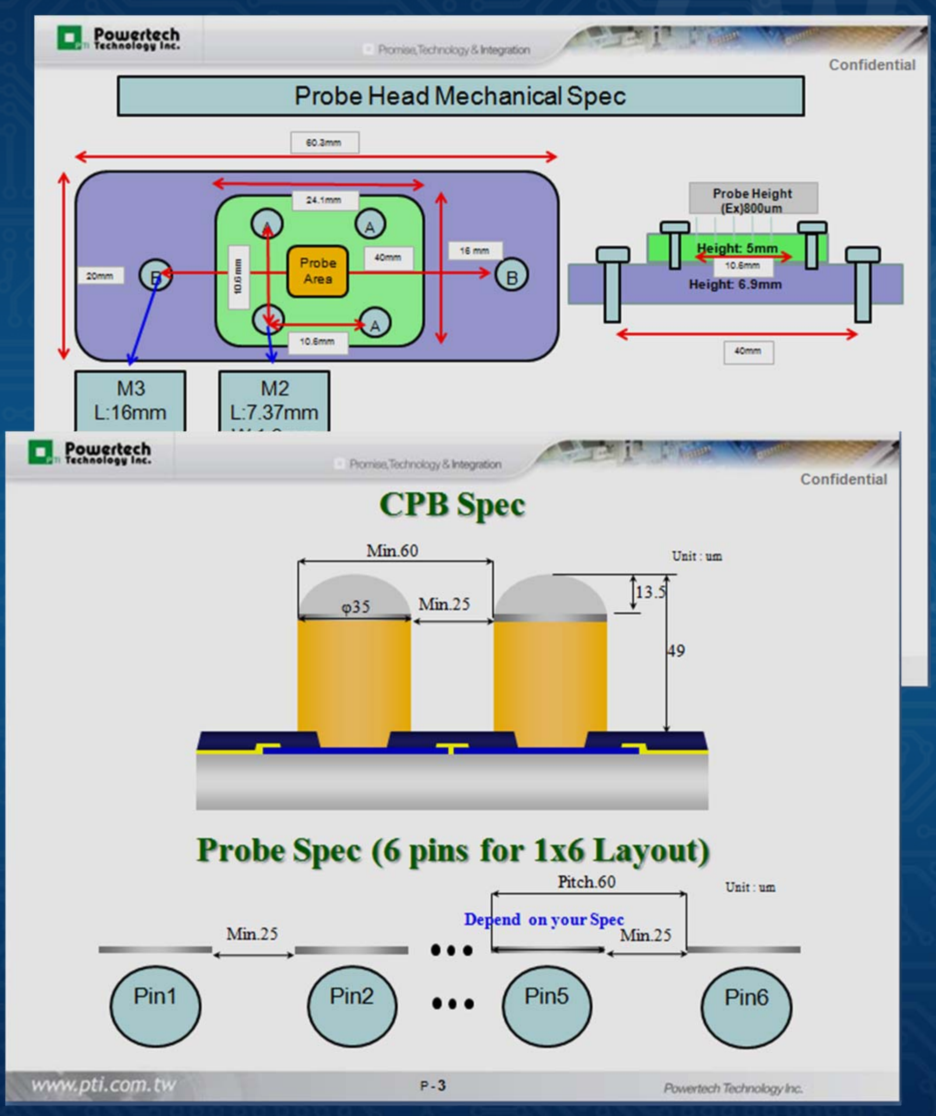
WLCSP

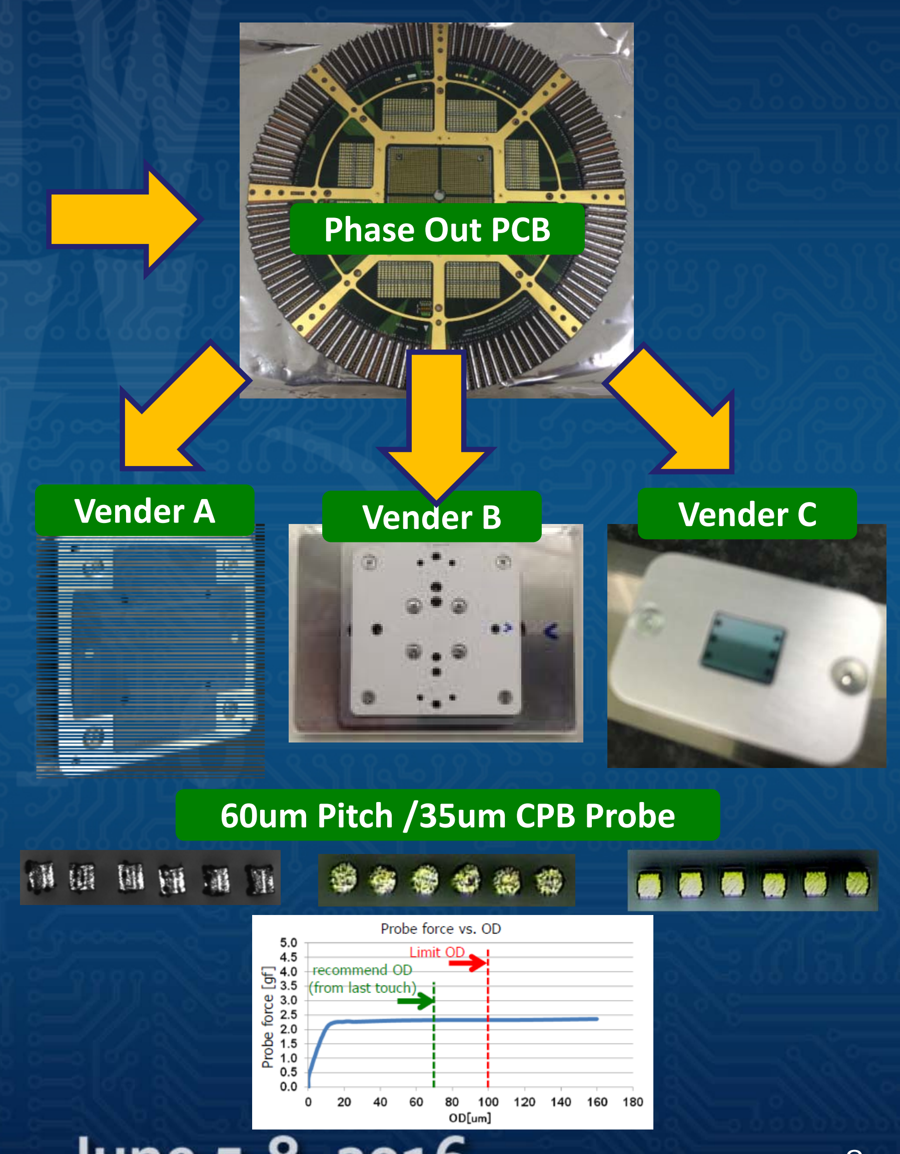
RDL

CPB

Consider for both I/F and Material as New Requirement from Schedule / Cost / Resource / Performance Evaluation Factors

(1)CPB Test Vehicle@35(D)/60(P)um





CPB Mechanical DOEs

DOE1- Normal Contact

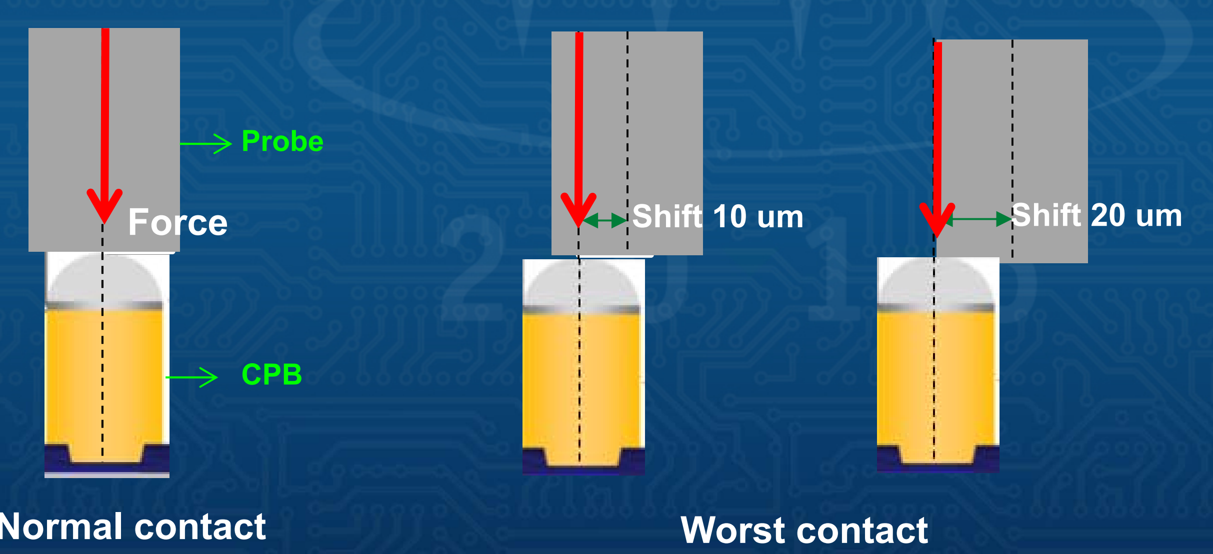
① Probe contact to bump center.
② Check OD vs. Probe Mark Area <25%.
③ **Make OD vs. Probe Mark Area Chart**

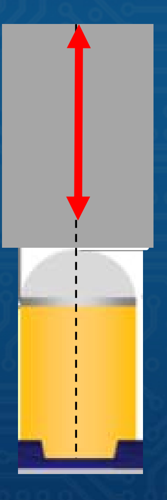
DOE2- Worst Contact

① Probe contact shift 10/20um to bump center.
② Use DOE1 recommend OD for probing.
③ **Check the cap w/i any creak at the worst condition.**

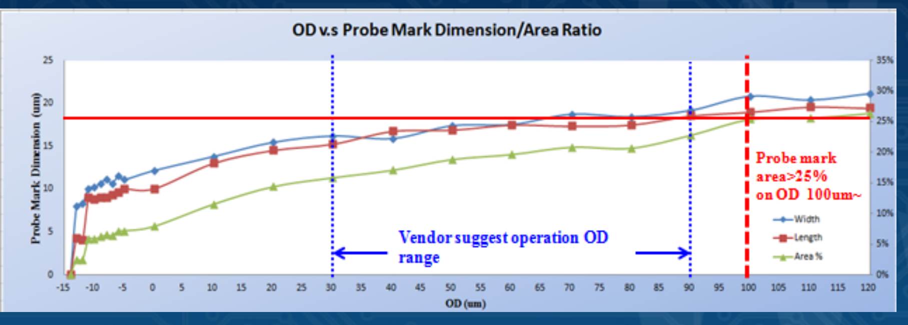
DOE3- Repeat Contact

① Use DOE1 recommend OD for probing.
② **Confirm maximum contact counts which don't make bump crack or deform.**

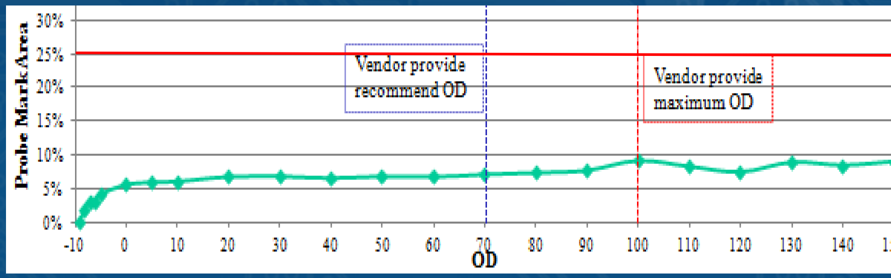




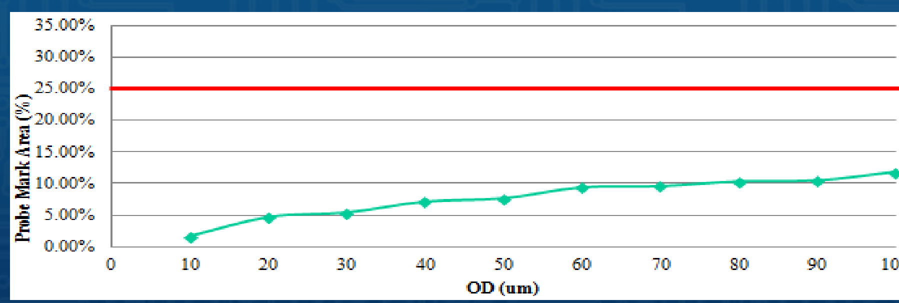
Normal Contact DOEs



OD	Width	Length	Probe mark area (<25%)	Probe mark
10um	13.76um	13.01um	11.48%	
50um	17.35um	16.89um	18.78%	
100um	20.79um	18.99um	25.35%	



OD (um)	Probe Mark Area(%)	Probe Mark
90	7.68%	
100	9.15%	
110	8.28%	



OD (um)	Probe Mark Area(%)	Probe Mark
10	1.69%	
50	7.67%	
100	11.83%	

<25% Probe mark Area

No CPB Damage <25% Probe mark Area

Worst Contact DOEs

Shift 10um

OD	Focus	Probe Mark Area (%)	Probe Mark (Contact)
30um	74	17.18%	
	72		
	70		
90um	76	25.75%	
	74		
	72		

Shift (um)	OD (um)	Probe Mark Area(%)	Probe Mark
10	40	7.02%	
	70	7.82%	
	100	8.18%	

OD (um)	Probe Mark
10	
40	
70	

Shift 20um

OD	Focus	Probe Mark Area (%)	Probe Mark (Contact)
30um	74	16.30%	
	72		
	70		
60um	75	20.98%	
	73		
	71		

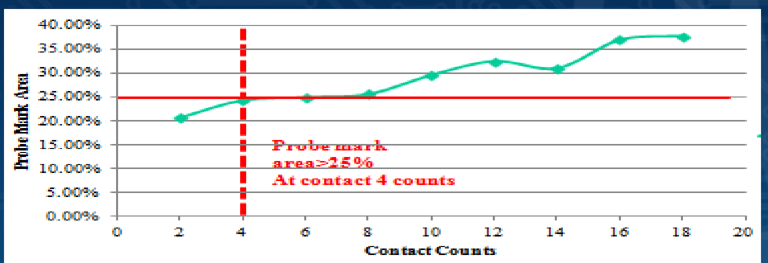
Shift (um)	OD (um)	Probe Mark Area(%)	Focus	Probe Mark
20	40	11.08%	79	
			82	
	70	12.2%	81	
			85	

OD(um)	Probe Mark
10	
40	
70	

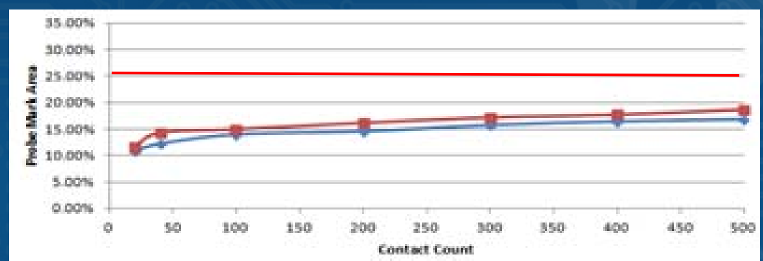
No CPB Damage <25% Probe mark Area

CPB Damage <25% Probe mark Area

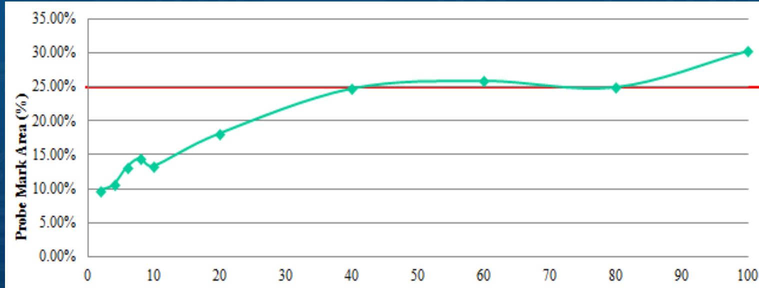
Repeat Contact DOEs



Contact counts	Average Area (%)	Maximum Area (%)	Probe Mark
2	18.54%	20.76%	
4	21.29%	24.37%	
6	23.46%	25.00%	



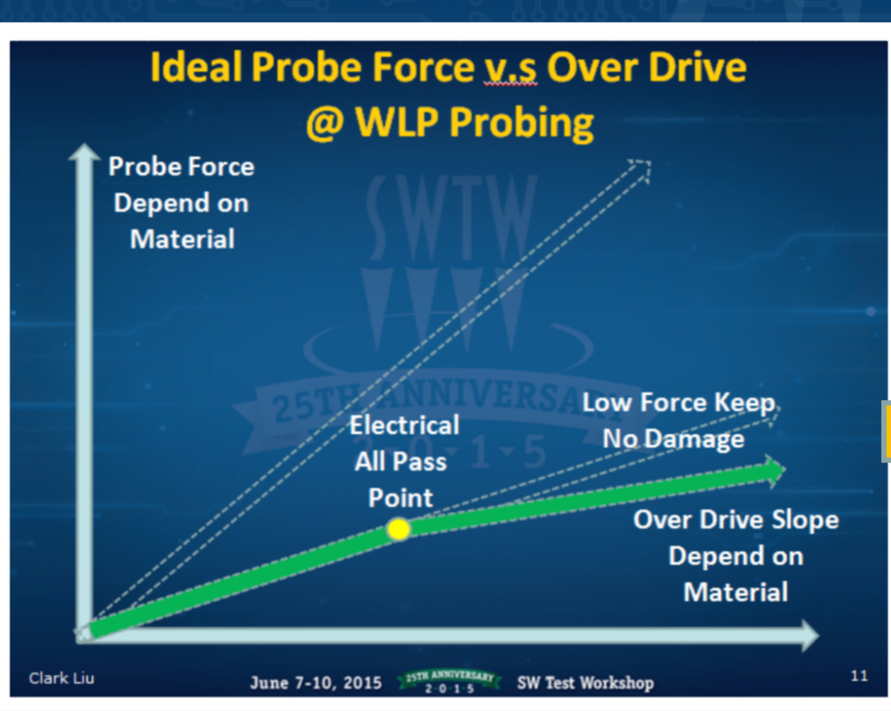
Contact Counts	Average Area (%)	Maximum Area (%)	Probe Mark
20	10.76%	11.59%	
40	12.13%	14.24%	
100	13.92%	14.90%	
200	14.50%	16.10%	

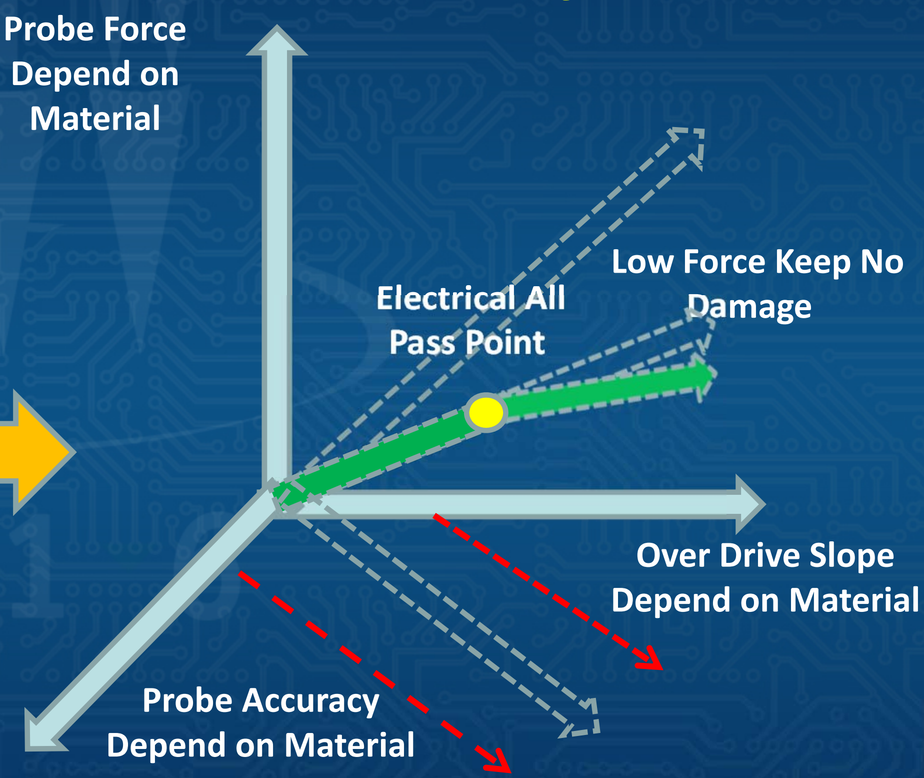


Contact Count	Probe Mark Area(%)	Probe Mark
2	9.75%	
10	13.34%	
60	25.92%	

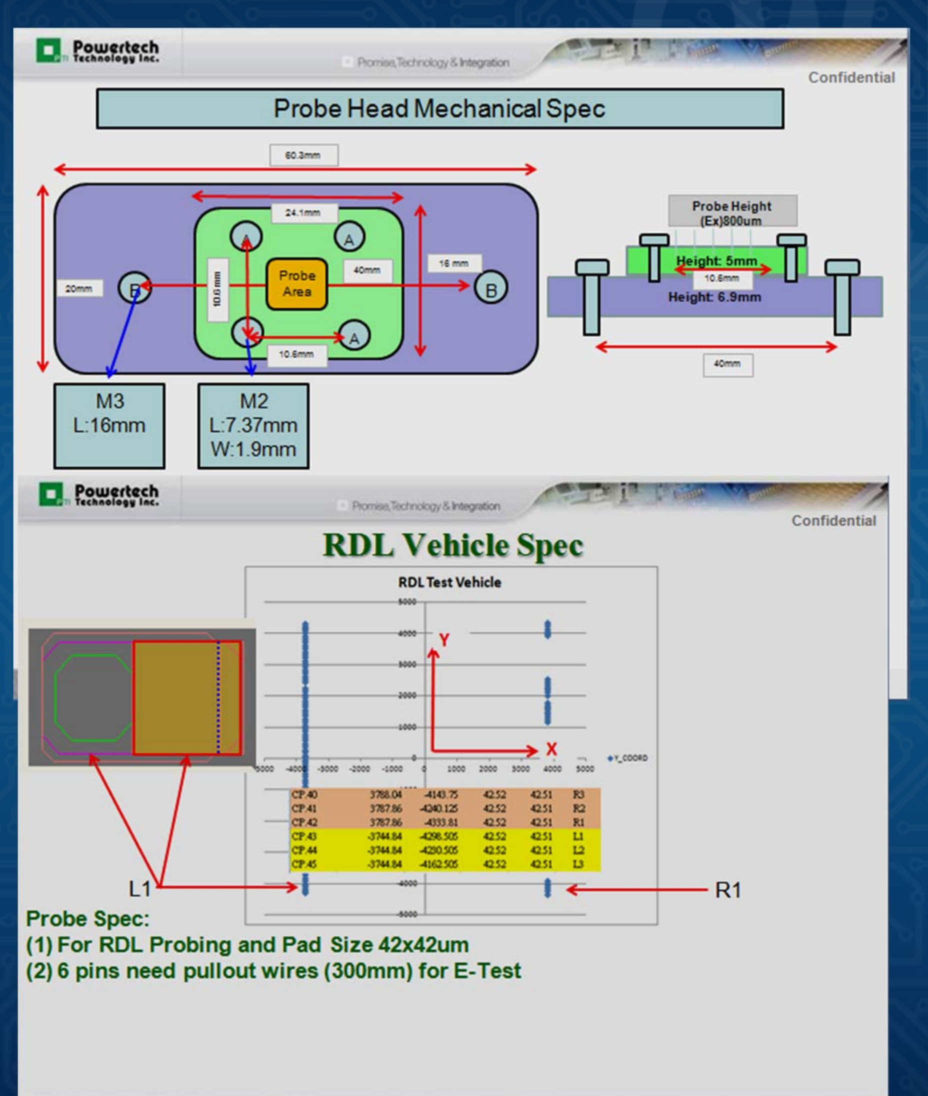
No CPB Damage <25% Probe mark Area

What Learning from CPB DOE

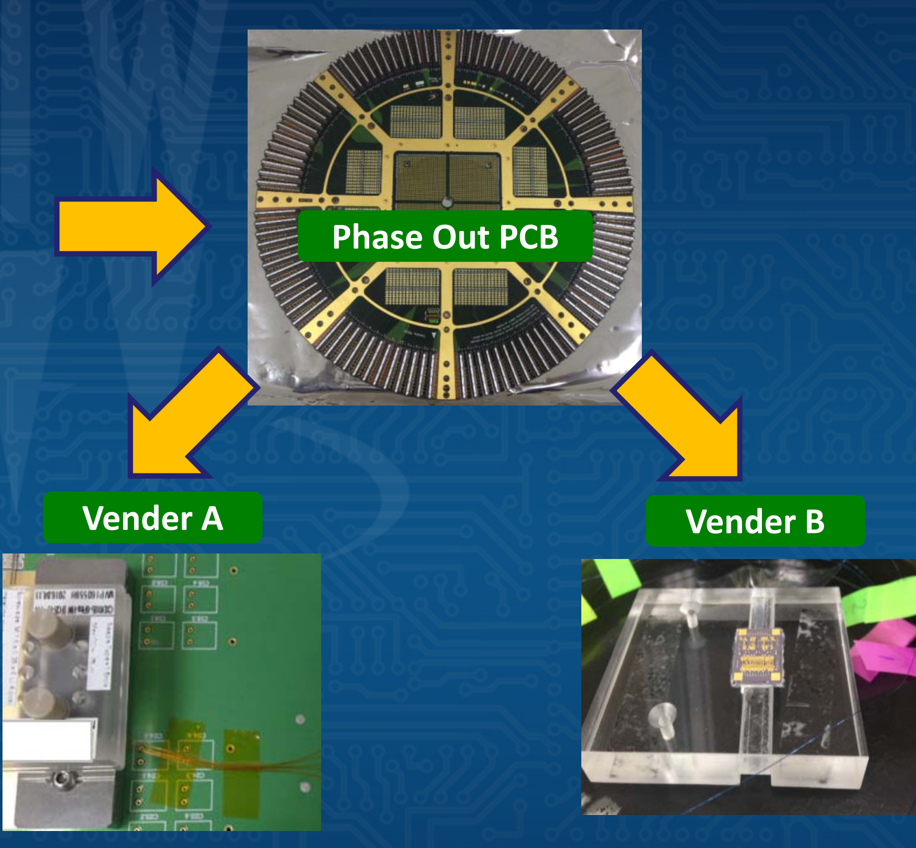




(2)RDL Test Vehicle



CP.40	3788.04	-4143.75	42.52	42.51	R3
CP.41	3787.86	-4240.125	42.52	42.51	R2
CP.42	3787.86	-4333.81	42.52	42.51	R1
CP.43	-3744.84	-4298.505	42.52	42.51	L1
CP.44	-3744.84	-4230.505	42.52	42.51	L2
CP.45	-3744.84	-4162.505	42.52	42.51	L3



Add Soldering wires for E-Test

Change Stiffener to Acrylic for Reduce Cost/Cycle Time

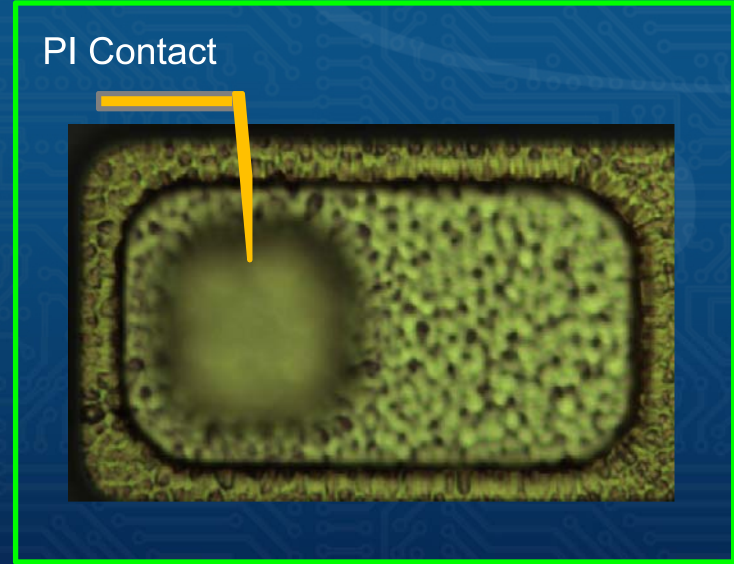
RDL Mechanical/Electrical DOEs

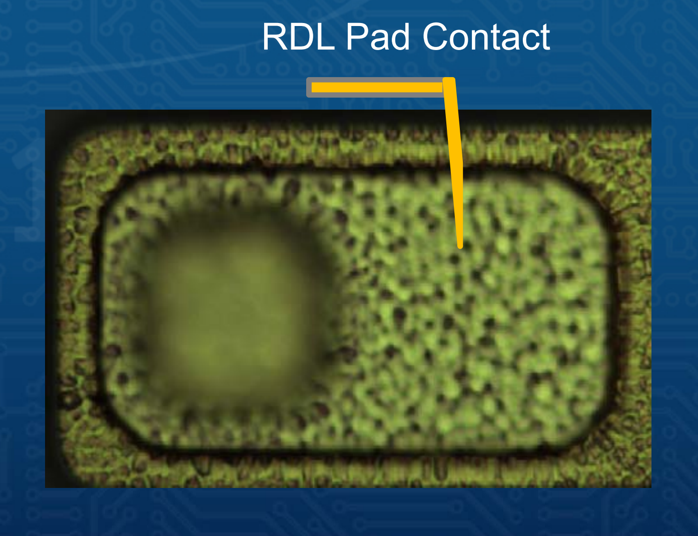
DOE1- Normal Contact

① Probe contact to RDL Pad (PI Opening) center.
② Check resistance w/i difference OD.
③ **Make OD vs. Resistance Chart**

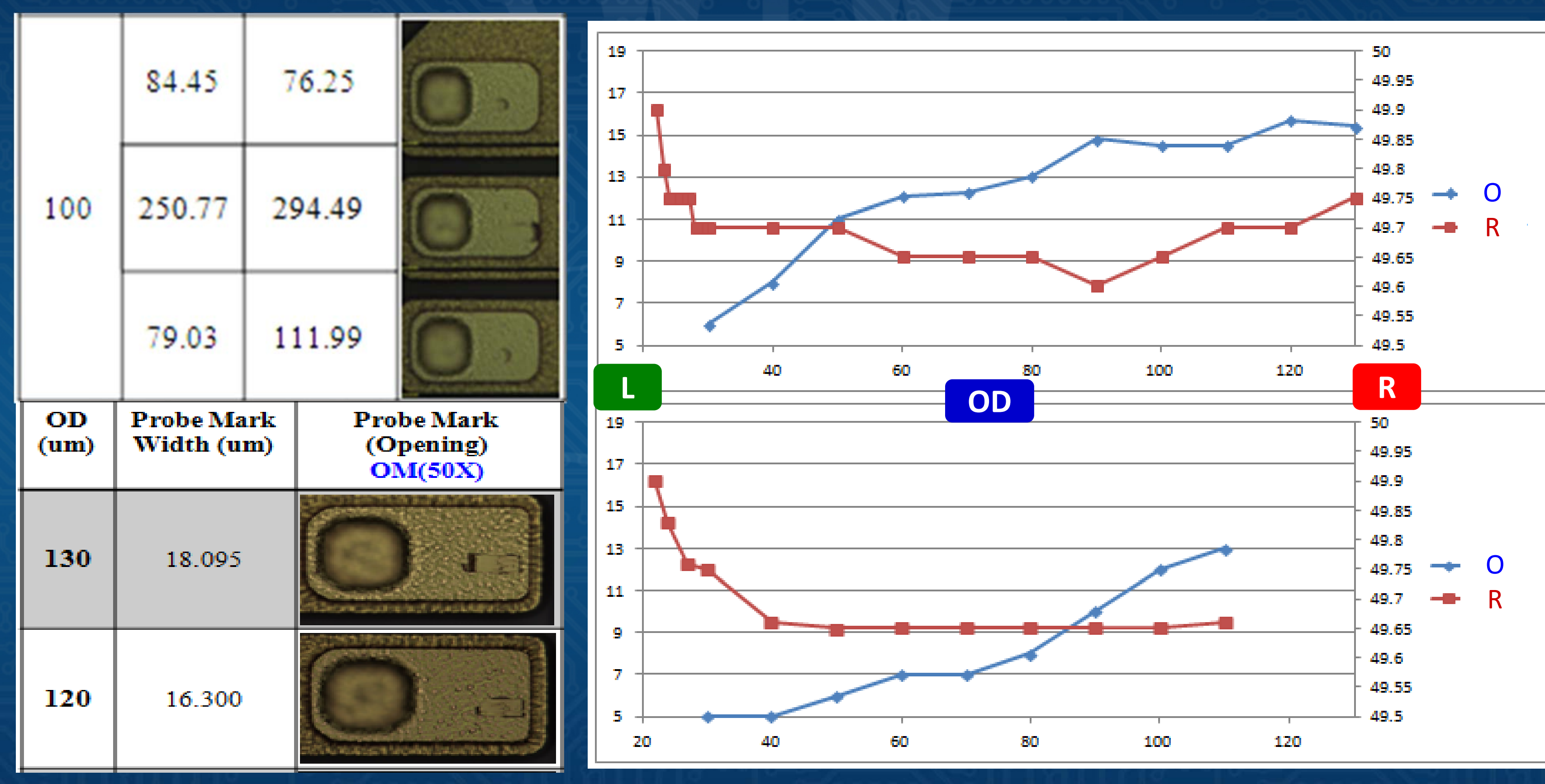
DOE2- Continuous Contact

① Using same OD Probing
② Check the resistance change after continuous contact.
③ **Make OD vs. Resistance Chart**



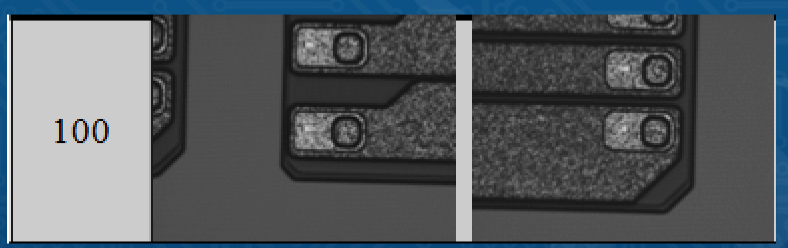


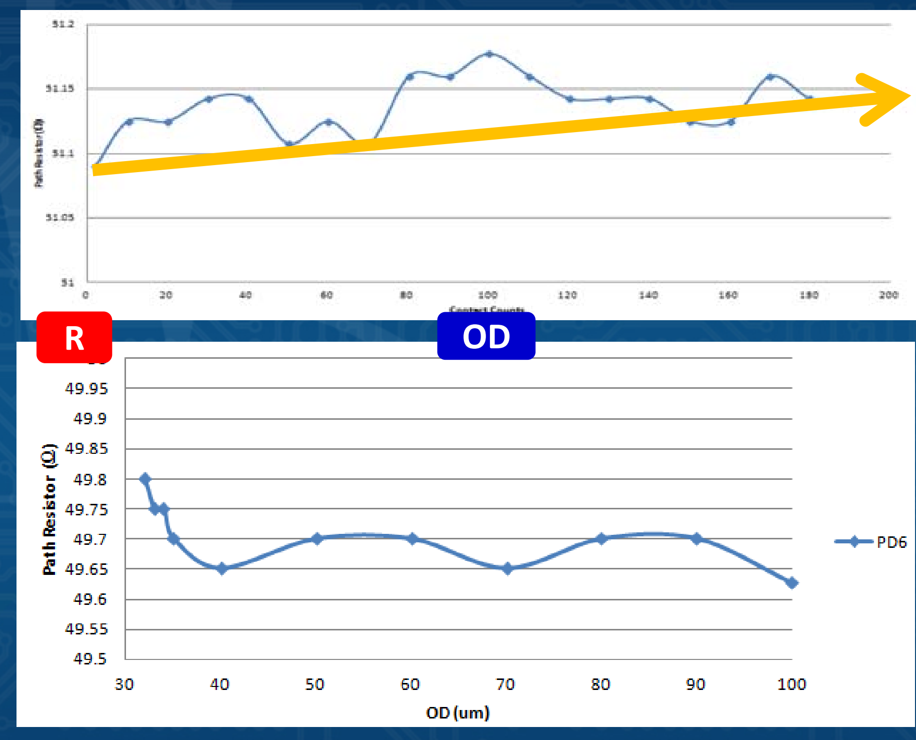
RDL DOE: Over Drive / RDL Probe Mark Length / Resistance



RDL DOE: Repeat Contact Resistance

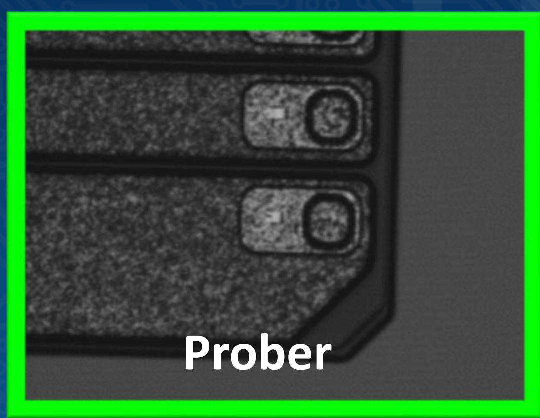
OD (um)	Probe Mark Microscope	Coordinate Prober
100		(6,-1)~(15,-1) (6,-2)~(15,-2) (6,-3)~(15,-3) (6,-4)~(15,-4)

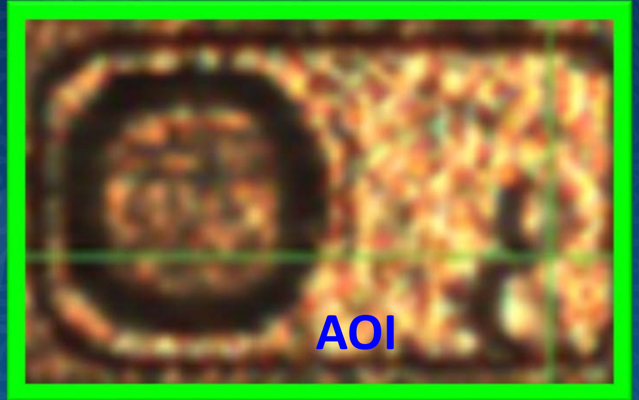


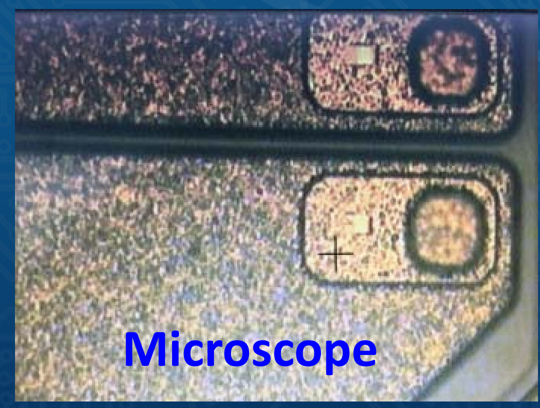


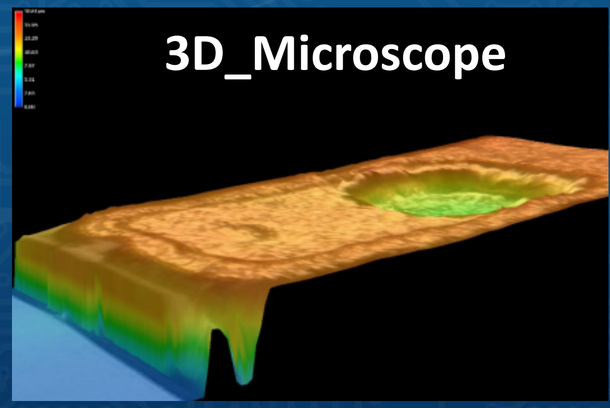
What Learning from RDL DOE

Probe mark Inspection Issue





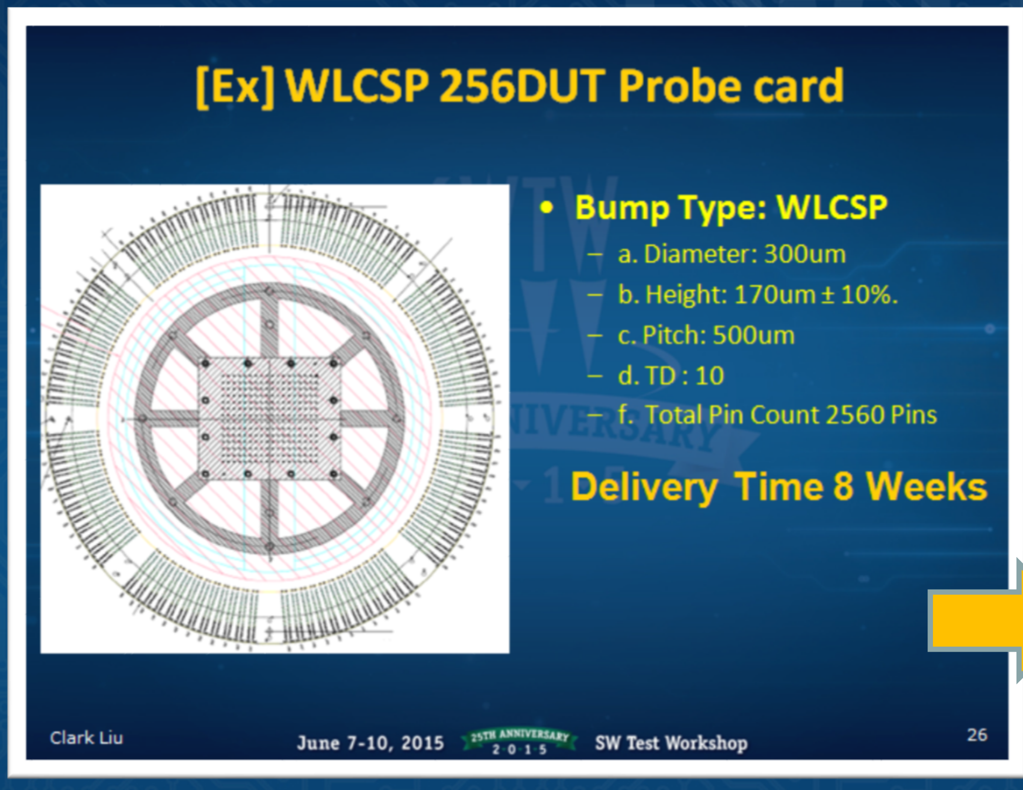


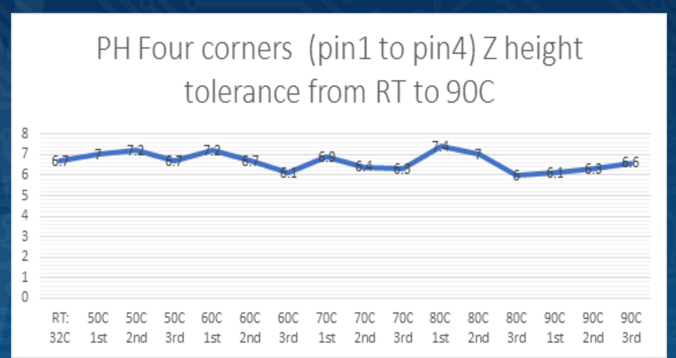


Probe mark Inspection still Keep the learning curve for HVM

(3)WLCSP Probe Card

High Parallelism Capability for Mass Production Case





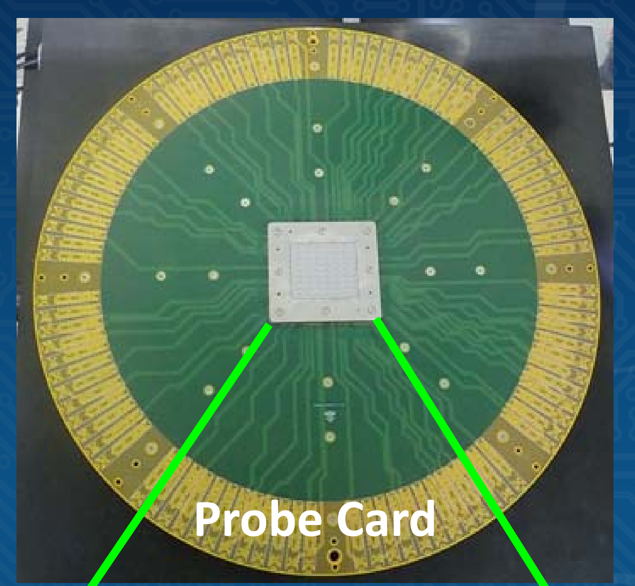
Thermal Stable Capability proven on large active area

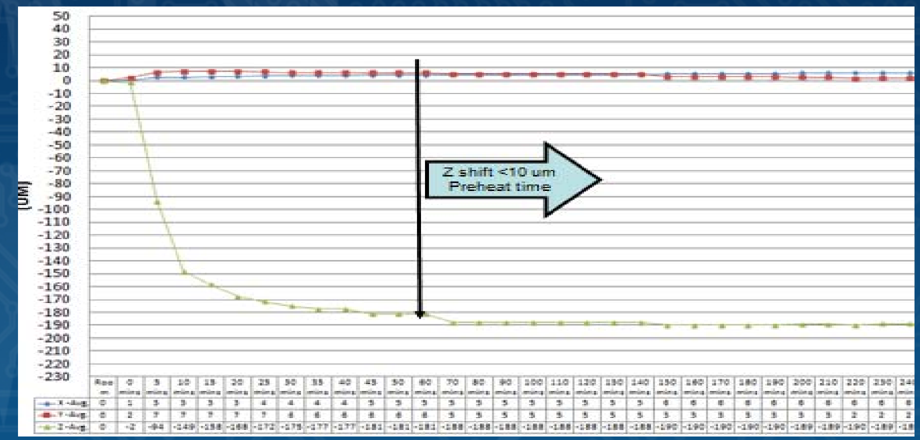
"Qi-Lin"Probe head size: 118mmx130mm

- **Production OT: 160um from 1st touch**
- **Probe force @ recom OT: 20-25g per pin**
- **Cleaning Freq: ~ every 300 TD**
- **Life-time: >500k**

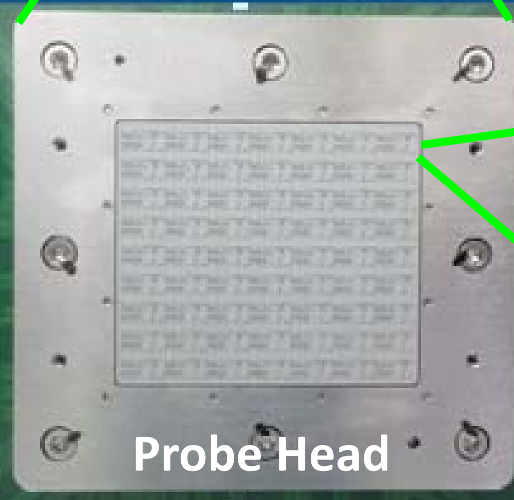
As Engineering DOE Data to extend the High Parallelism Capability for NPI, Make the Production Card for HVM.

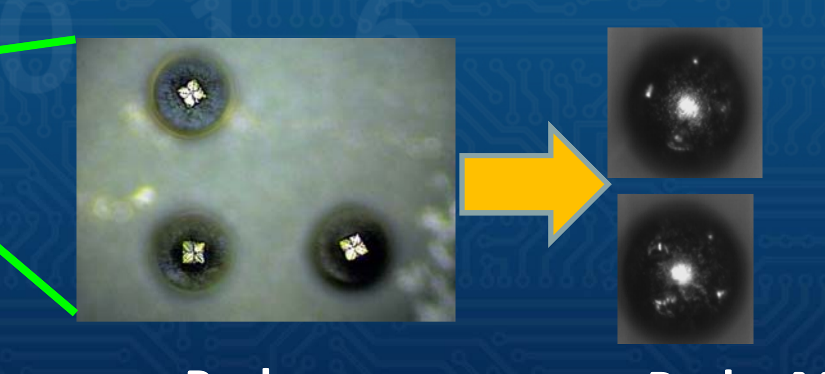
WLCSP Probe card_DRAM_64DUTs





HT Thermal Soak Time

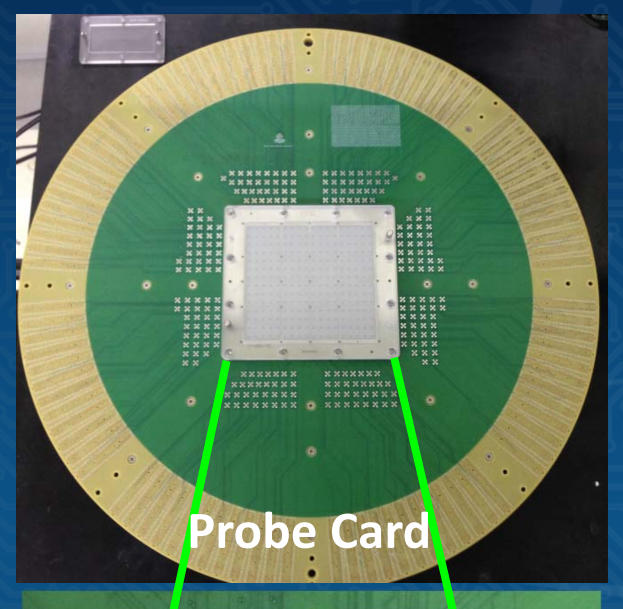


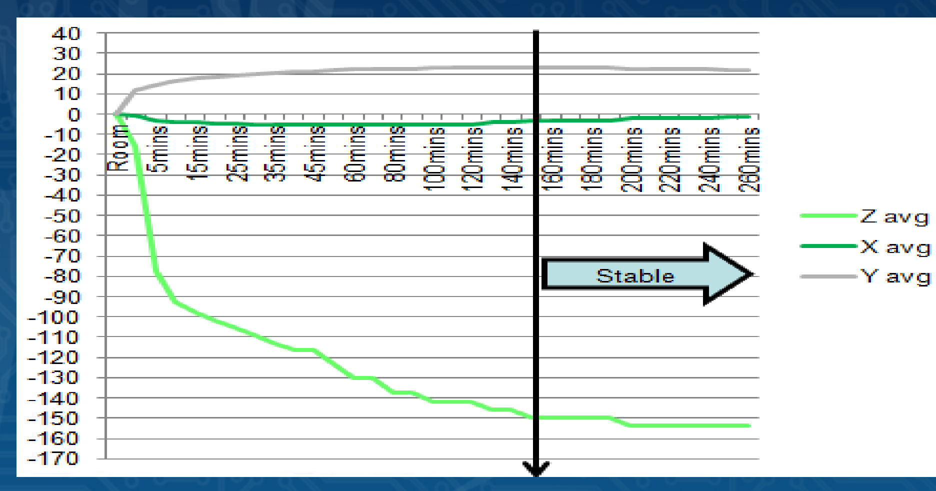


Probes

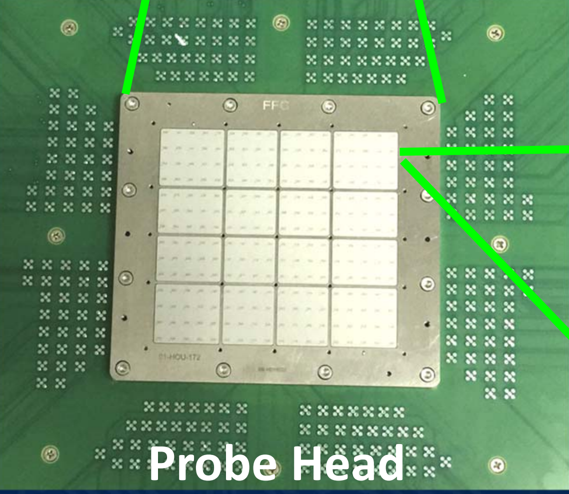
Probe Mark

WLCSP Probe card_Flash_256DUTs





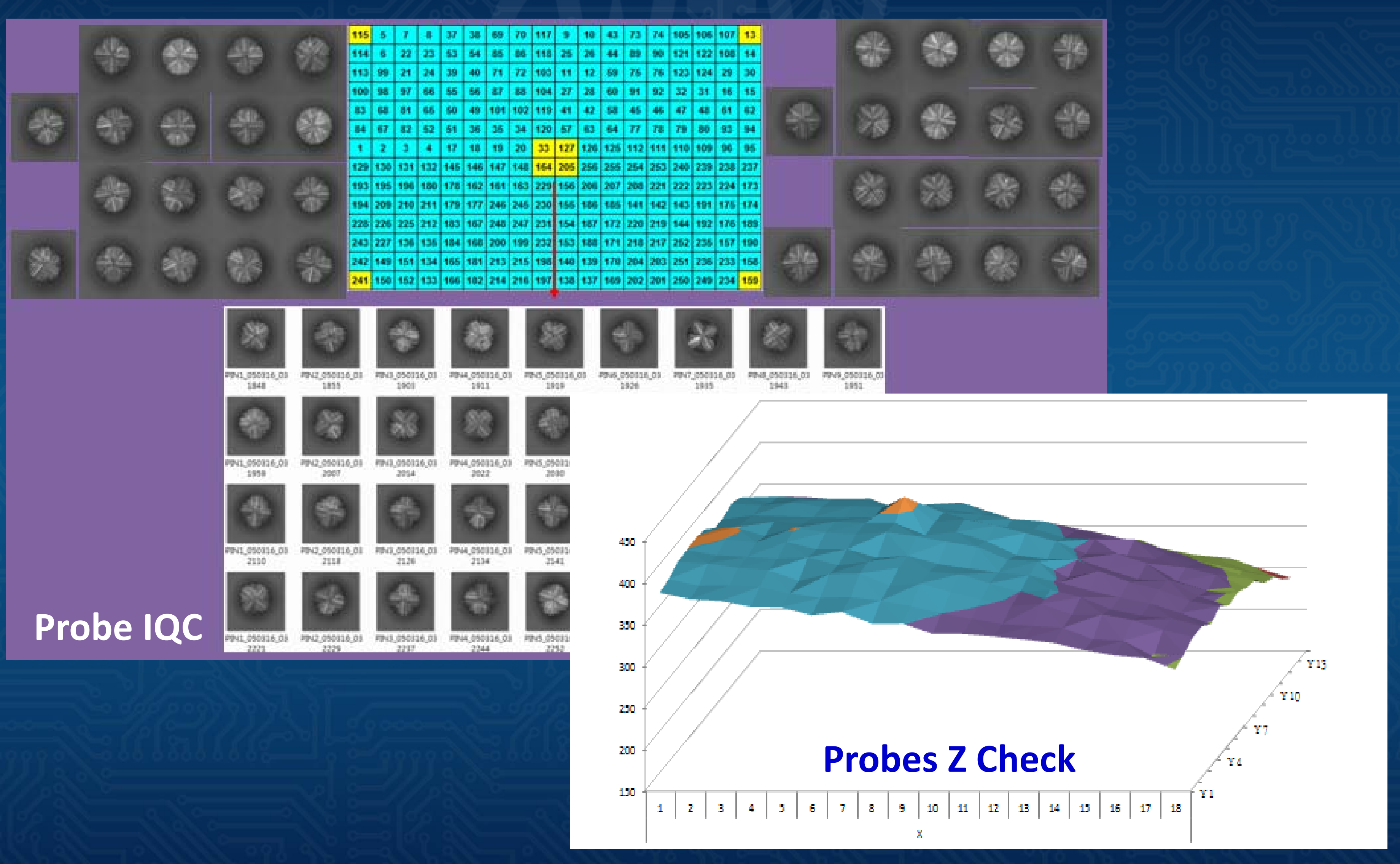
HT Thermal Soak Time



Probes

Probe Mark

WLCSP Probe card_Probe Check



Future Work:

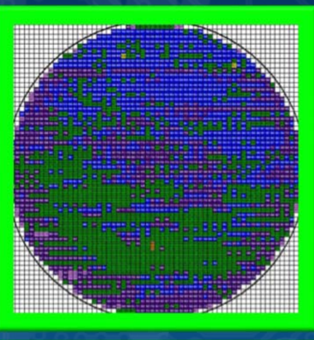
(1) AOI for WLP Probe mark?

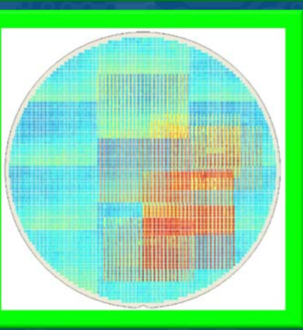
CPB

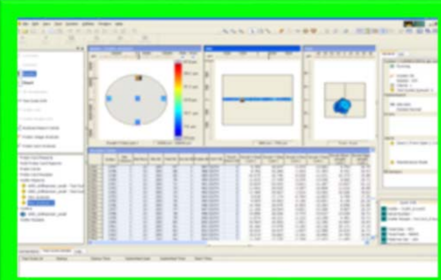
RDL

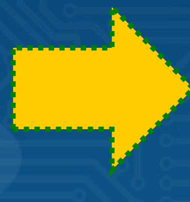
WLCSP

AOI
Probe
mark
Analysis









User
Expect
Data

Data Mining:

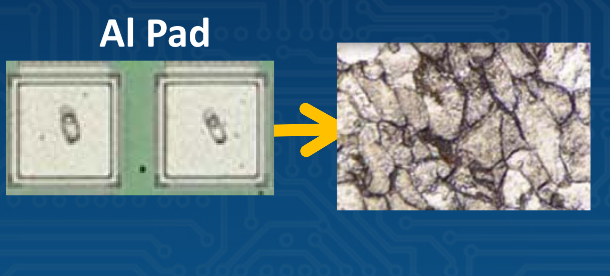
(1) Prober
Performance
(2)Probe card
Performance

[Keep Under
Development]

Future Work :

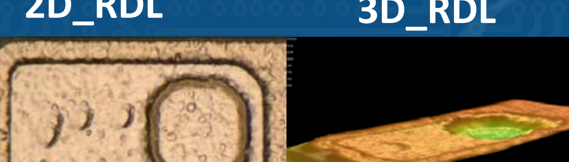
(2) Build 3D Microscope for WLP / Probe card Engineering Analysis

Al Pad

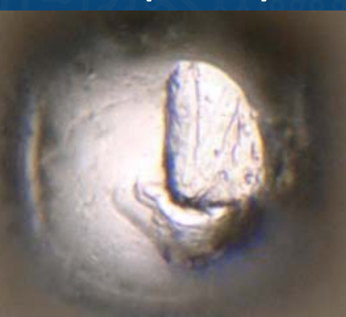


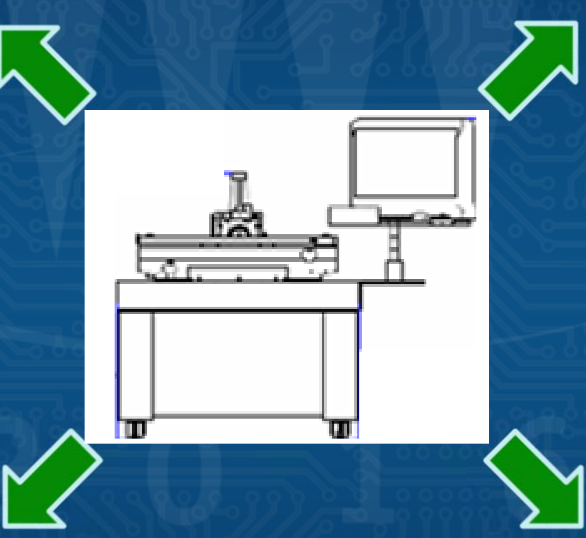
2D_RDL

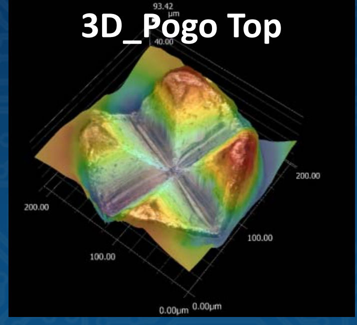
3D_RDL

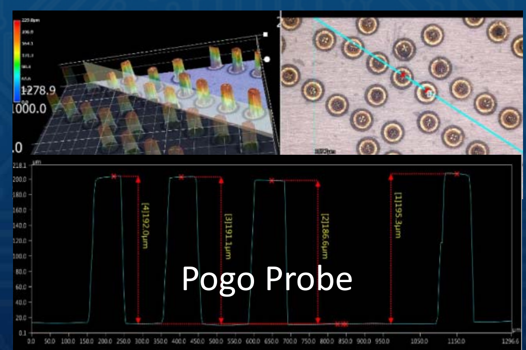


CPB(x5000)









Check both for Wafer and Probe card Inspection and Measurement

Quickly Feedback and Learning for Each Team

Vender A
Vender B
Vender C

PTI

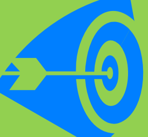
DOE A
DOE B
DOE C

Probe Characterize
Contact Material
Probe card Performance
New DOE Model
Probe Mark
E-Test

Challenge
Probing
Vision
Recipe

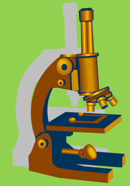
Cooperation
AOI Vender
Clean Vender

Conclusion



Business

Saving Cost



Validation

DOE Tool Evaluation

New Application

Communication

New Concept

Share Technology

MFG Technology

Build up new working model for easy work!

Acknowledgments

We would like to thank colleagues for their support in preparation of this presentation.

(1)FFI: Alan Liao / Daniel Liang

(2)JEM: Atsushi Mine / Chikaomi Mori

(3)MPI: Mark Sun / Albert Fan / Curtis Hsu

(4)PTI: Henry Tseng / William Mo / Toby Chen

Thank you!