SWTEST
PROBE TODAY, FOR TOMORROW
2022 CONFERENCE

Methodology to improve WAT probe card Probe Mark and Lifetime

Eric Sik Kiang Lau, Tai Lin Goh, Tee Whay Lim
(GLOBALFOUNDRIES, Singapore, Singapore)

Qu Yang, Yang, Toh Wei Leong, Jean Tan, Jeffrey Lam
(STAr-Quest Technologies, Singapore, Singapore)

Yu-Ming Chien (Star Technologies – Hsinchu City, Taiwan)

June 5 - 8, 2022

Introduction / Background

- Introduction what's ET structure
  - WAT (Wafer Acceptance Test), also known as ET (Electrical Test) is an important step prior to wafers shipment from foundry to their customers. The tests include process control monitors such as diodes, transistors and resistors that are situated at the wafer scribe lines (die saw region). Normally, 9-17 sites per wafer are being tested.
- Pad size reduce trend → Reference: >100nm:~80um, ~65nm:~50um, <55nm:<~40um
- CPC is more cost-effective solution vs VPC

	CPC	VPC
Min Pitch	50um	50um
Min Pad Size	50 x 50um	25 x 25um
Lifetime	CPC touchdown	2* CPC touchdown
Cost	CPC Cost	3* CPC Cost
Cost per 1M Touch down	CPC Cost/1Mil TD	1.5 * CPC Cost/1Mil TD

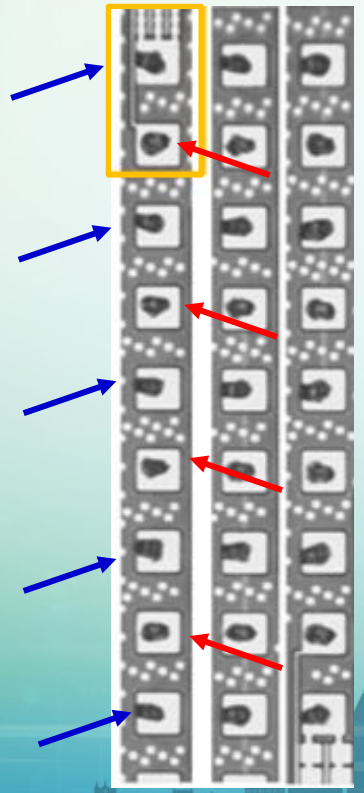
Objectives / Goals

- Goal: Optimize current CPC solution to fulfill probing requirement of advanced technology nodes
  - Pad size requirement
    - Test pad size 36 x 36um which current CPC solution
    - probe margin requirement < 5um

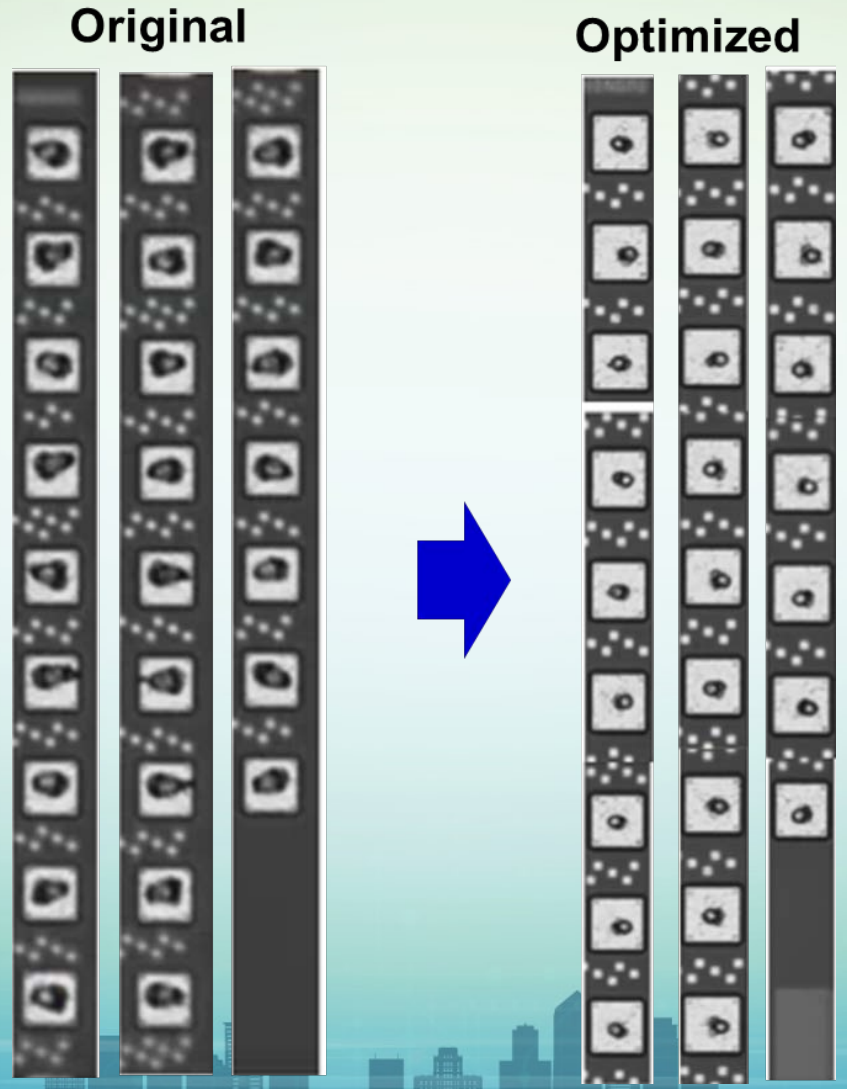
- Challenges
  - Zig Zag probe mark issue
  - Smaller scrub mark
  - Longer lifetime

Challenges

- Zig Zag probe mark issue → Uneven probe mark occurs
  - Observed Odd Pins are touching edge and even pins have shorter scrub length
  - Happens on dual fan out card

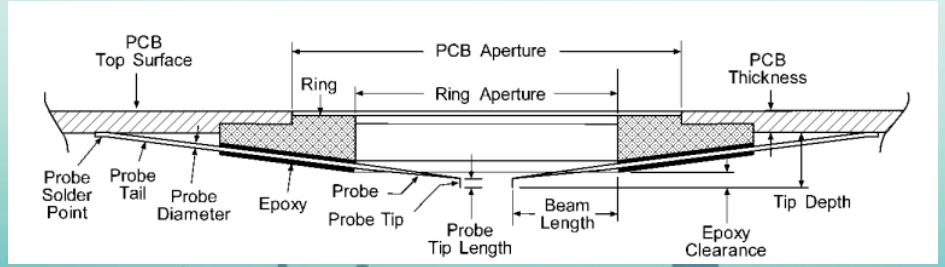


Outcome after Optimization



Methods / Materials / Procedures

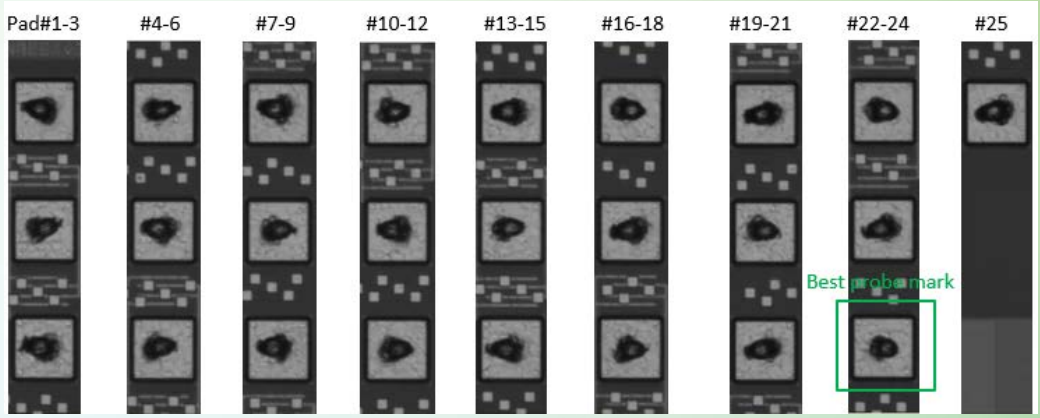
- Changing Needle Spec
  - Bending Angle
    - Usually set at 94°. together with beam angle , bending angel will affect how vertical the pin will be. When pin probing straight down to pad. The probe mark will be smaller , however there is risk to damage pin tip
  - Tip Diameter
    - The smaller tip diameter gives smaller probe mark , but higher risk to bend the pin tip
  - A & P Offset
    - Applied when needle fan-out from both side. Probe tip, instead of align in one straight line, will be adjusted towards needle body. So that when probe pin contact wafer will be slide towards the center of the pads.
  - Reduce BCF (Balanced contact force)
    - The smaller BCF will get smaller probe mark but higher contact resistance, Reduced BCF needs to achieve balanced point which use smallest force to get solid contact and acceptable contact residence.



Summary Of Experiments

	Original	Exp #1	Exp #2	Exp #3
Tip Diameter	Standard	Std – 4um	Std – 4um	Std – 4um
BCF	Standard	Std – 0.5g/mil	Std – 0.5g/mil	Std – 0.5g/mil
A&P offset	Standard	Std – 3um	Std – 3um	Std – 3um
Bending Angle	Standard	Standard	Std – 4°	Std – 4°
Bending Position	Standard	Standard	Standard	Move forward

Original Probe Mark



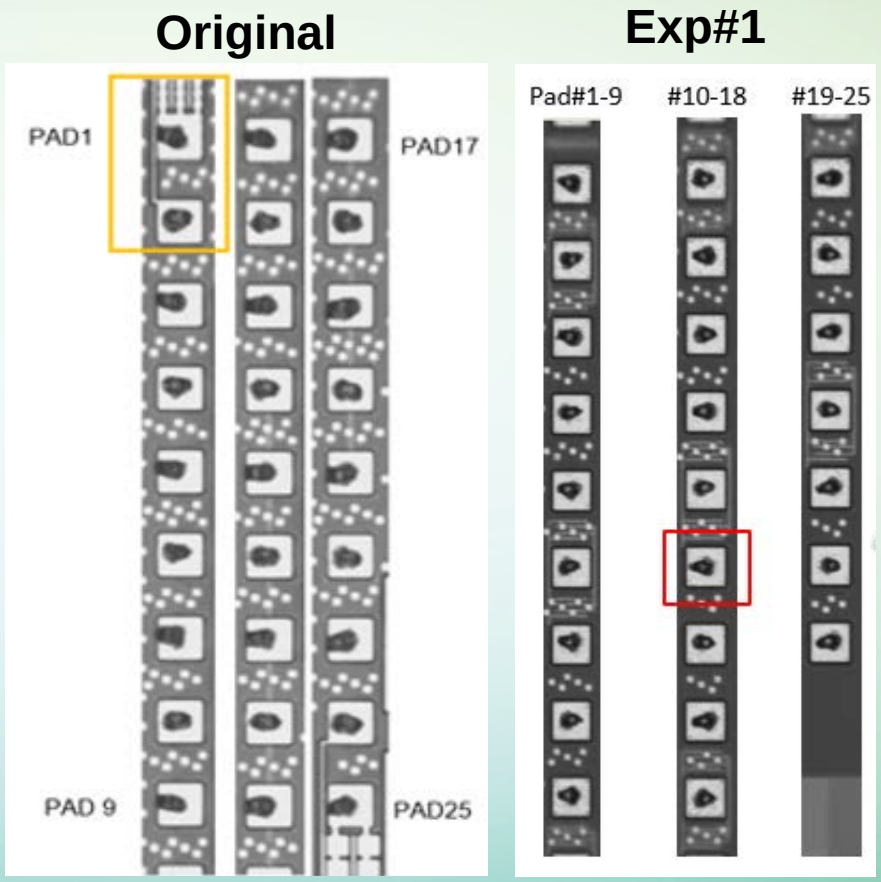
- Exp 3 can achieve small probe mark while lifetime increased to 3*N mil TD compared to N mil TD in Original

Original Vs Exp1

	Original	Exp #1
Tip Diameter	Std	Std - 4um
BCF	Std	Std – 0.5g/mil
A&P offset	Std	Std - 3um

- **Optimization Done**
  - Reduced tip diameter
  - Reduced BCF
  - Reduced A&P Offset

- **Exp#1 Advantage**
  - Smaller probe mark
  - More centralized

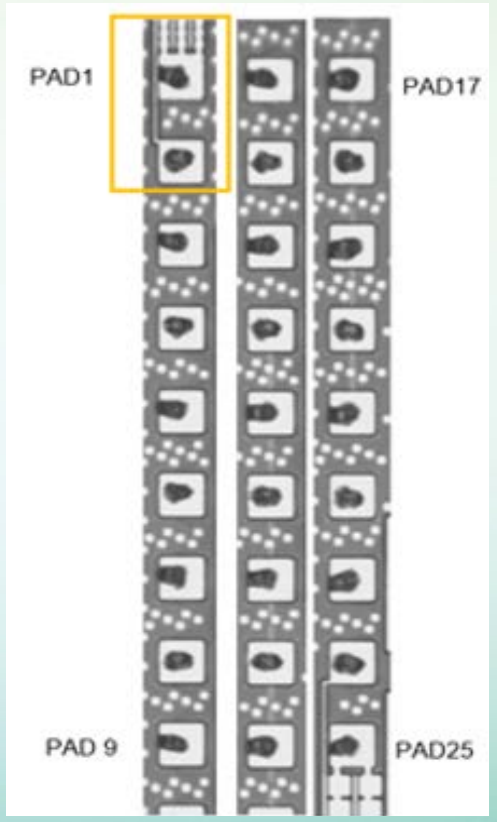


Original Vs Exp1

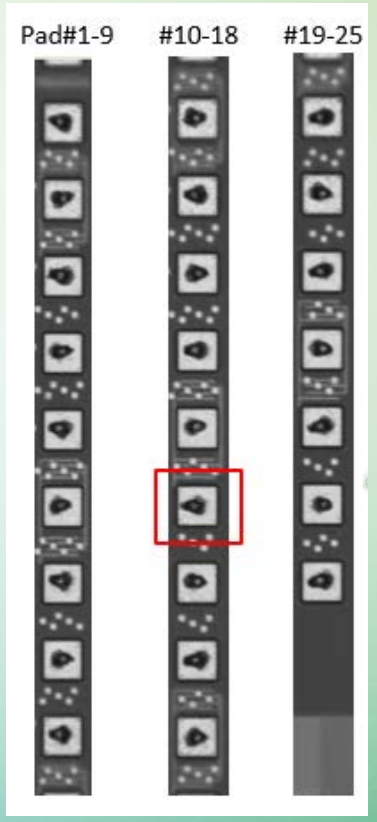
	Original	Exp #1
Tip Diameter	Std	Std - 4um
BCF	Std	Std – 0.5g/mil
A&P offset	Std	Std - 3um

- **Optimization Done**
  - Reduced tip diameter
  - Reduced BCF
  - Reduced A&P Offset
- **Exp#1 Advantage**
  - Smaller probe mark
  - More centralized
- **Exp#1 Drawback**
  - Scrub Mark still can be further optimized

Original



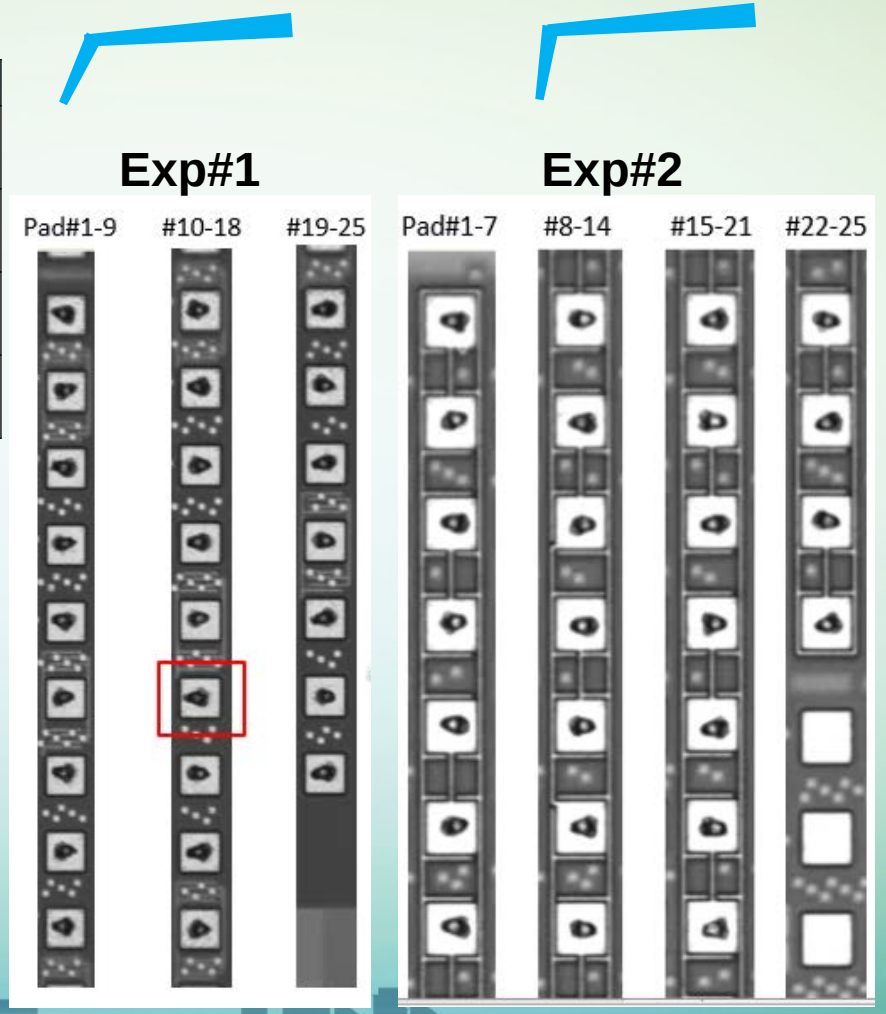
Exp#1



Original Vs Exp1 Vs Exp2

	Original	Exp #1	Exp#2
Tip Diameter	Std	Std -4um	Std - 4um
BCF	Std	Std – 0.5g/mil	Std – 0.5g/mil
A&P offset	Std	Std - 3um	Std – 3um
Bending Angle	Std	Std	Std – 4°

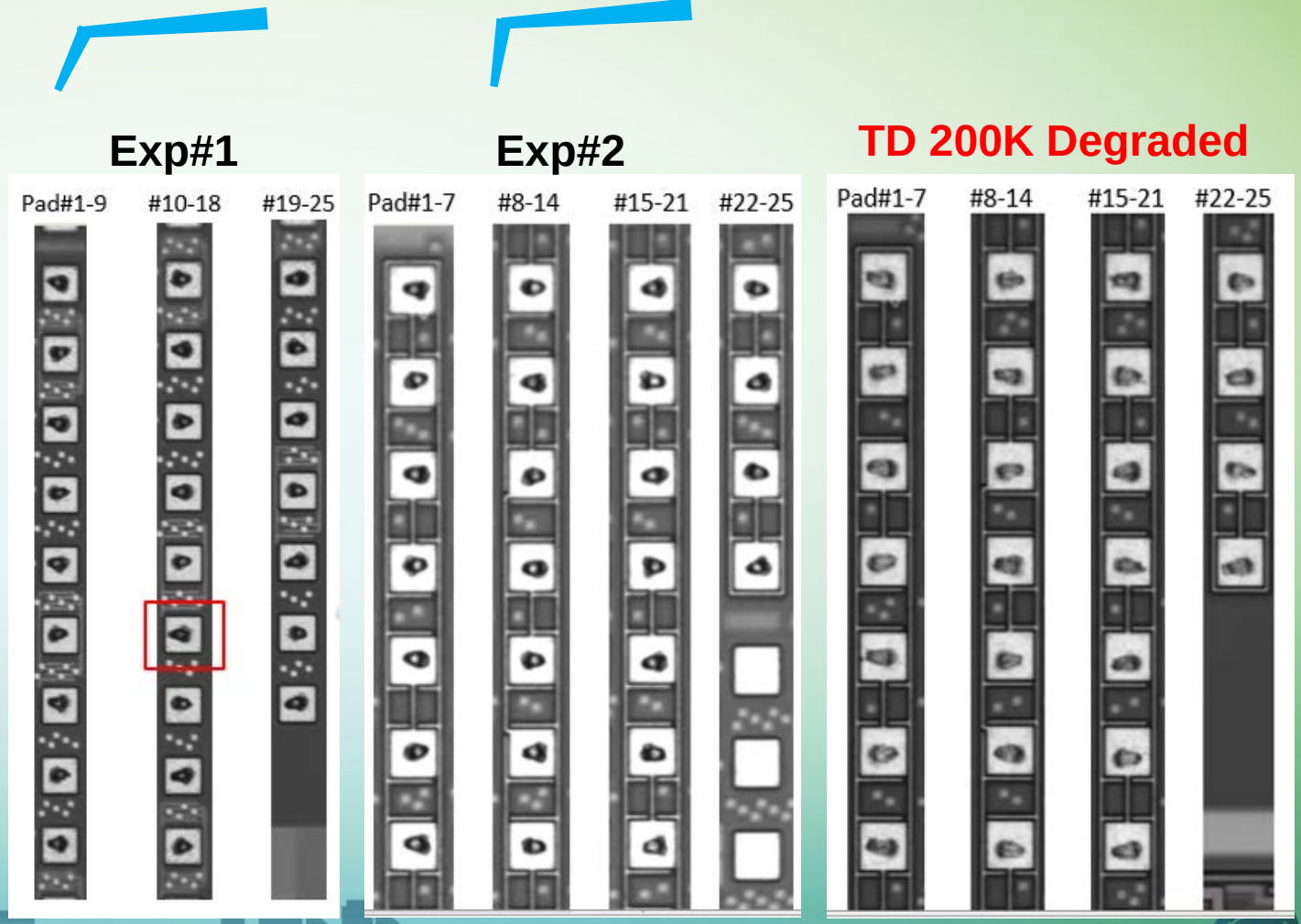
- **Optimization Done**
  - Bending angle reduced for 100+° to 96°
- **Exp#2 Advantage**
  - Smaller probe mark
  - More centralized



Original Vs Exp1 Vs Exp2

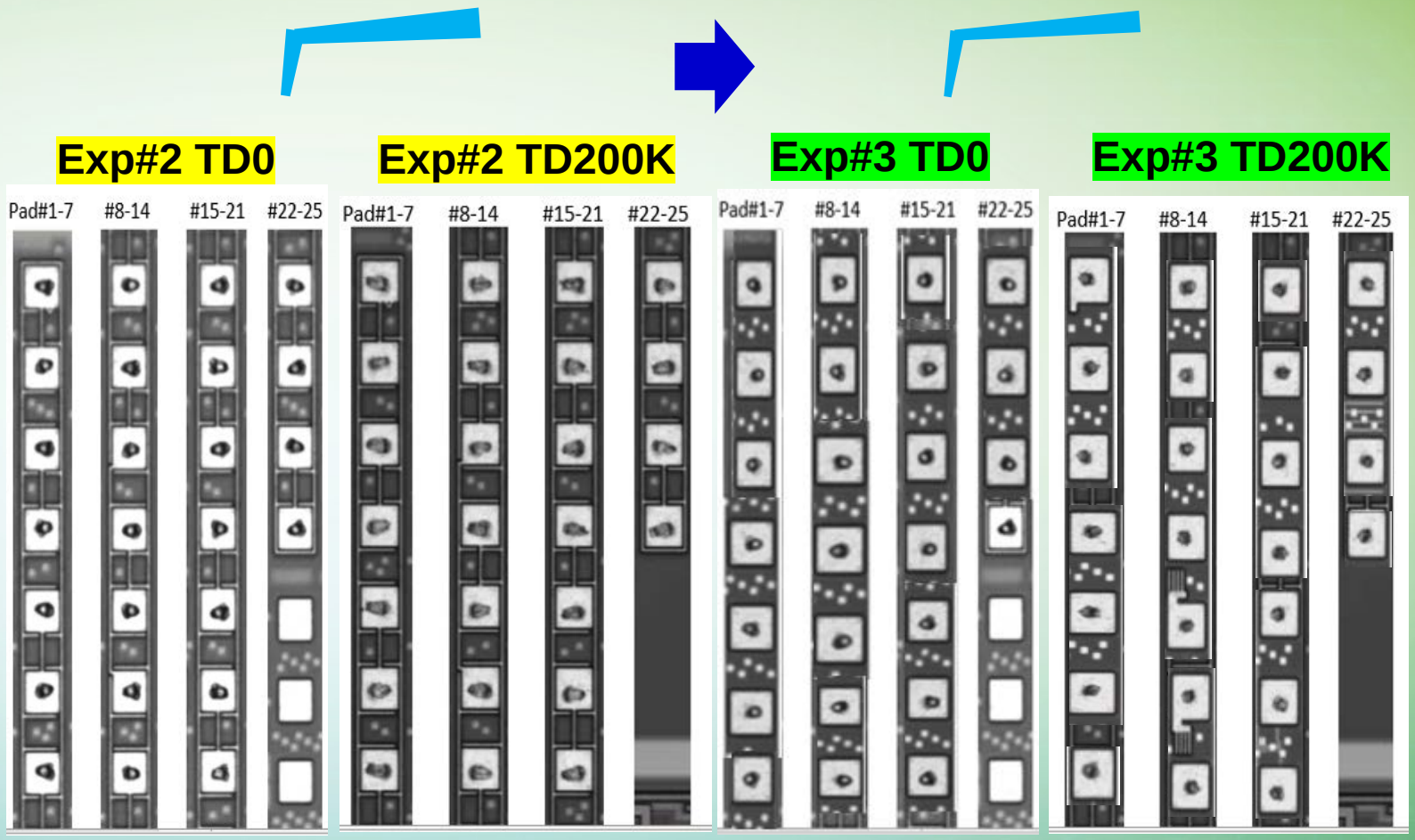
	Original	Exp #1	Exp#2
Tip Diameter	Std	Std - 4um	Std - 4um
BCF	Std	Std –0.5g/mil	Std – 0.5g/mil
A&P offset	Std	Std - 3um	Std - 3um
Bending Angle	Std	Std	Std – 4°

- **Optimization Done**
  - Bending angle reduced for 100+° to 96°
- **Exp#2 Advantage**
  - Smaller probe mark
  - More centralized
- **Exp#2 Drawback**
  - Probe Mark degrade with number of TD



Exp2 vs Exp3

	Exp #2	Exp #3
Tip Diameter	Std -4um	100um
BCF	Std – 0.5g/mil	3.0g/mil
A&P offset	Std - 3um	12um
Bending Angle	Std – 4°	Std – 4°
Bending position		**Move Forward**



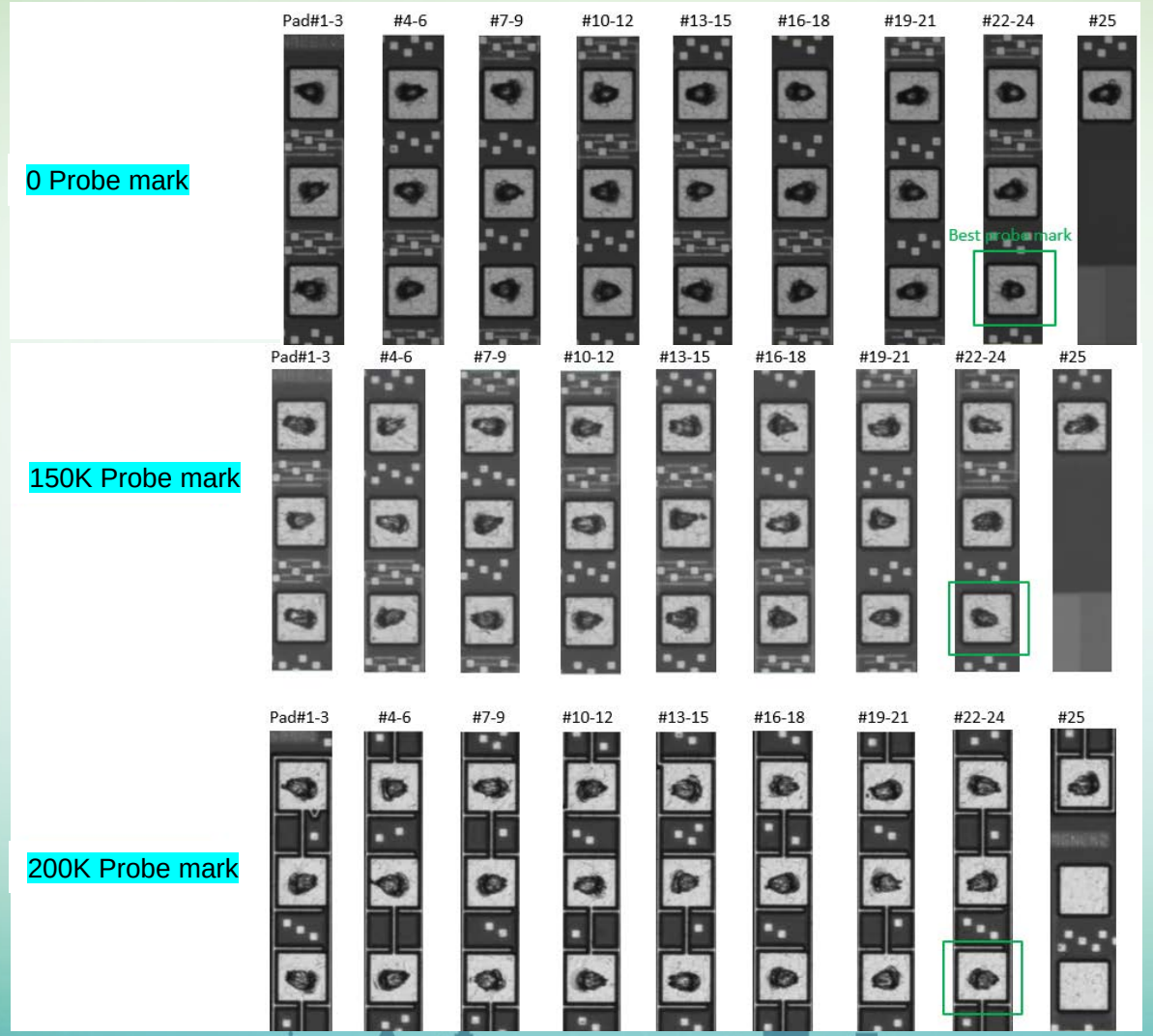
- After changing bending position, we obtained VPC alike probe mark

Optimization result summery

	Original	Exp1	Exp#2	Exp#3
Tip Diameter	Standard	**Std – 4um**	Std – 4um	Std – 4um
BCF	Standard	**Std – 0.5g/mil**	Std – 0.5g/mil	Std – 0.5g/mil
A&P offset	Standard	**Std – 3um**	Std – 3um	Std – 3um
Bending Angle	Standard	Standard	**Std – 4°**	Std – 4°
Bending Position	Standard	Standard	Standard	**Move forward**

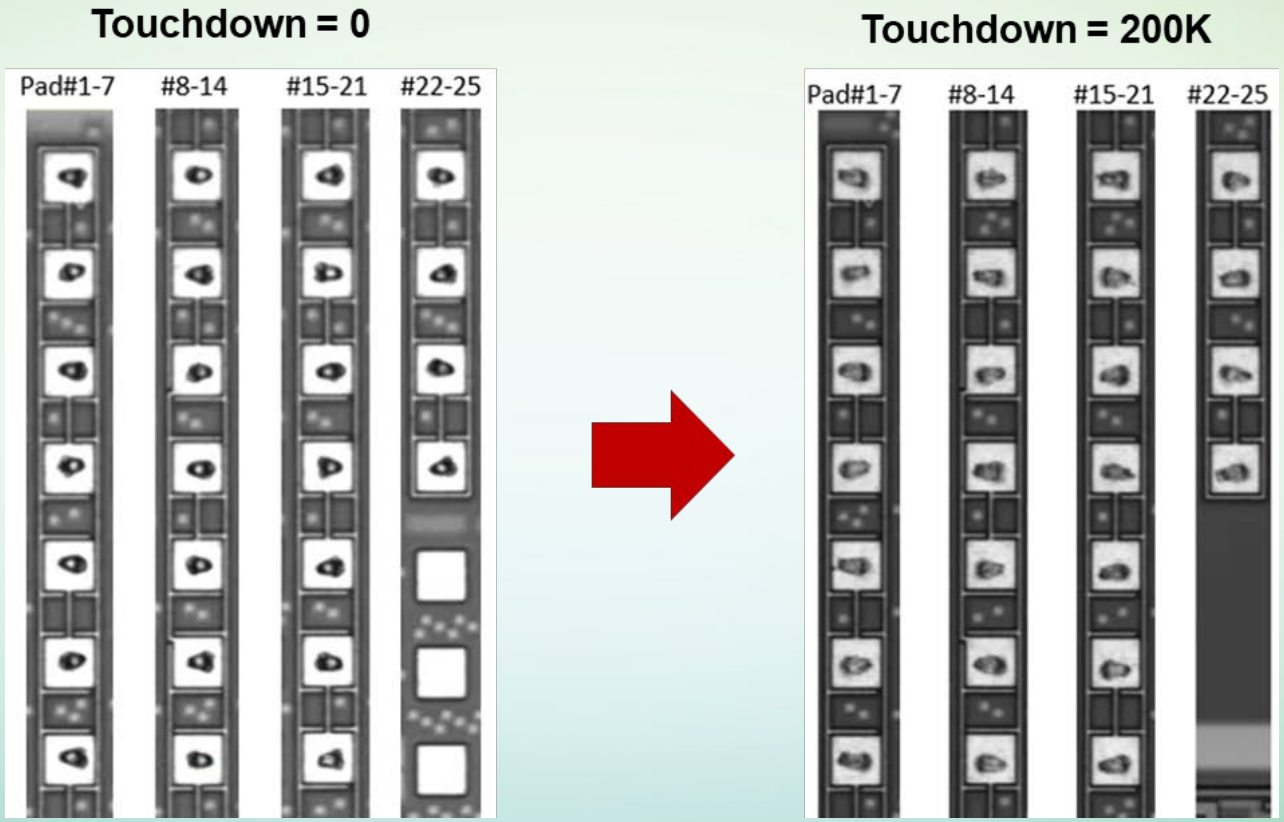
- Exp#1 shows smaller probe mark , but long scrub mark.
- Exp#2 improved scrub mark while keeping smaller probe mark, but probe mark degrades with number of touch down. Much larger probe mark at 200K touchdown
- Exp#3 much smaller probe mark and sustainable probe mark against touch down.

Probe Mark Vs touch down (Exp#1)



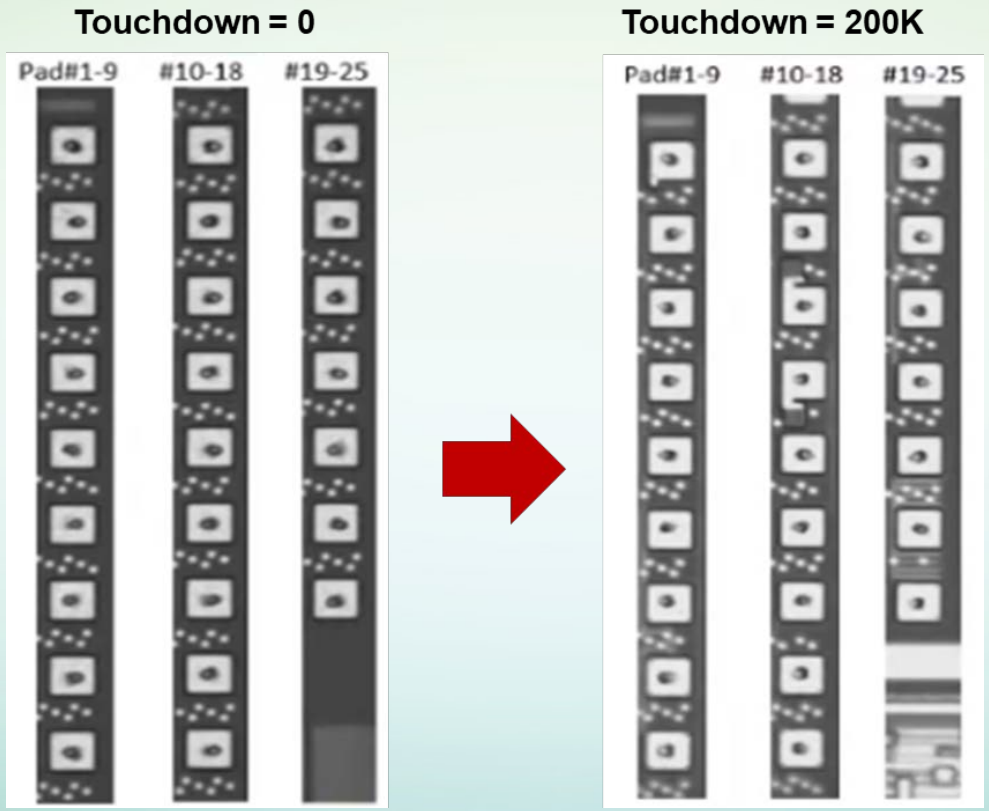
- Probe mark is getting bigger with increased number of touch down

Probe Mark Vs touch down (Exp#2)



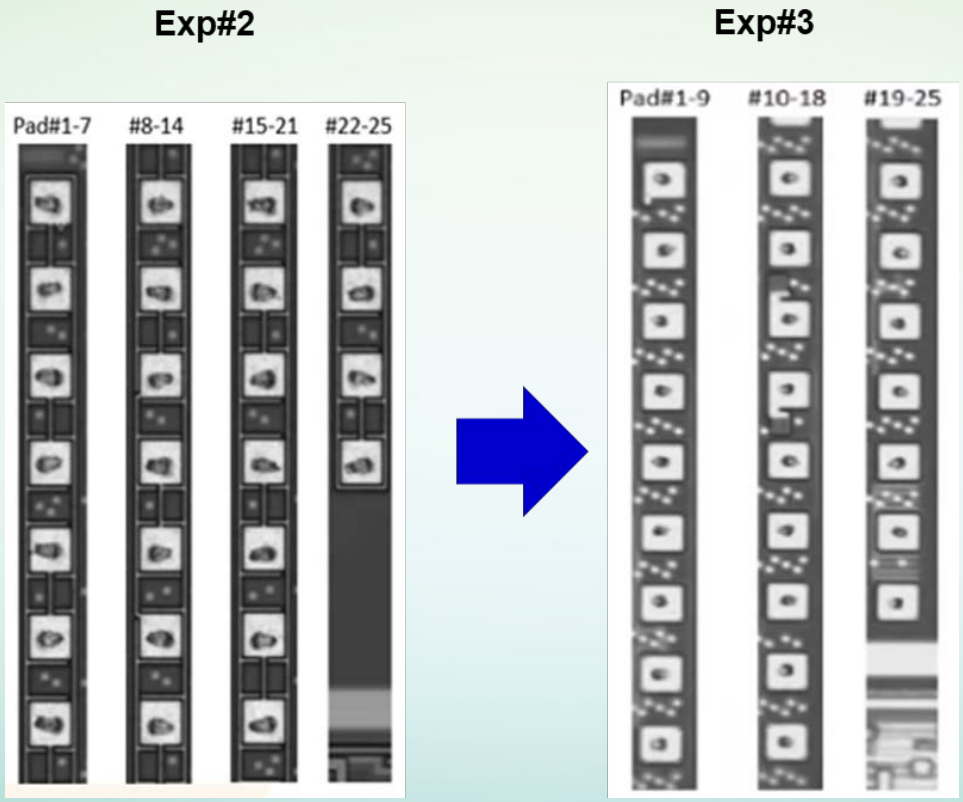
- Probe mark is ideal at 0 touch down, but degraded at 200K touchdown it's even worse than Exp#1

Probe Mark Vs touch down (Exp#3)



- With adjusted bending position probe mark perform well at 200K touchdown

Compare at 200K Touch down



- Exp#3 is greatly improved.

Lifetime comparison

	Original	Exp#1	Exp #2	Exp #3
Tip Diameter	Standard	**Std - 4um**	Std - 4um	Std - 4um
BCF	Standard	**Std – 0.5g/mil**	Std – 0.5g/mil	Std – 0.5g/mil
A&P offset	Standard	**Std - 3um**	Std - 3um	Std - 3um
Bending Angle	Standard	Standard	**Std – 4°**	Std – 4°
Bending Position	Standard	Standard	Standard	**Move forward**
Lifetime	N Mil TD	1.44 x N Mil TD	1.75 x N Mil TD	3 x N Mil TD

- Exp#3 show better lifetime in terms number of touchdown

Summary / Conclusion

- **Summary**
  - With optimization, current CPC solution can probe down to 28um x 28um pad size with 5um probe margin
  - Probe mark can maintain at good shape at min 200K touchdown
  - Lifetime has been improved from 3 times

- **Follow-On Work**
  - Continue to monitor the probe resistance consistency, make sure probe card contact with wafer properly with increased number of touch down
  - Evaluating new cleaning media to further extend the shelf-life of the probe pins is on-going.

Acknowledgement

- **GLOBALFOUNDRIES**
  - *Hein Mun Lam*
  - *Tual, Sian*

- **STAr-Quest Technology**
  - Grace Lin
  - Amber Lo
  - Sampson Chan
  - Wang Wei-Li
  - Chui-Hoon Tay
  - Song-Kim Lam