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Semiconductor Wafer Test Workshop
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An Innovative Design and Implementation of Vertical Probe Card for High Speed Loopback(12Gbps) Application

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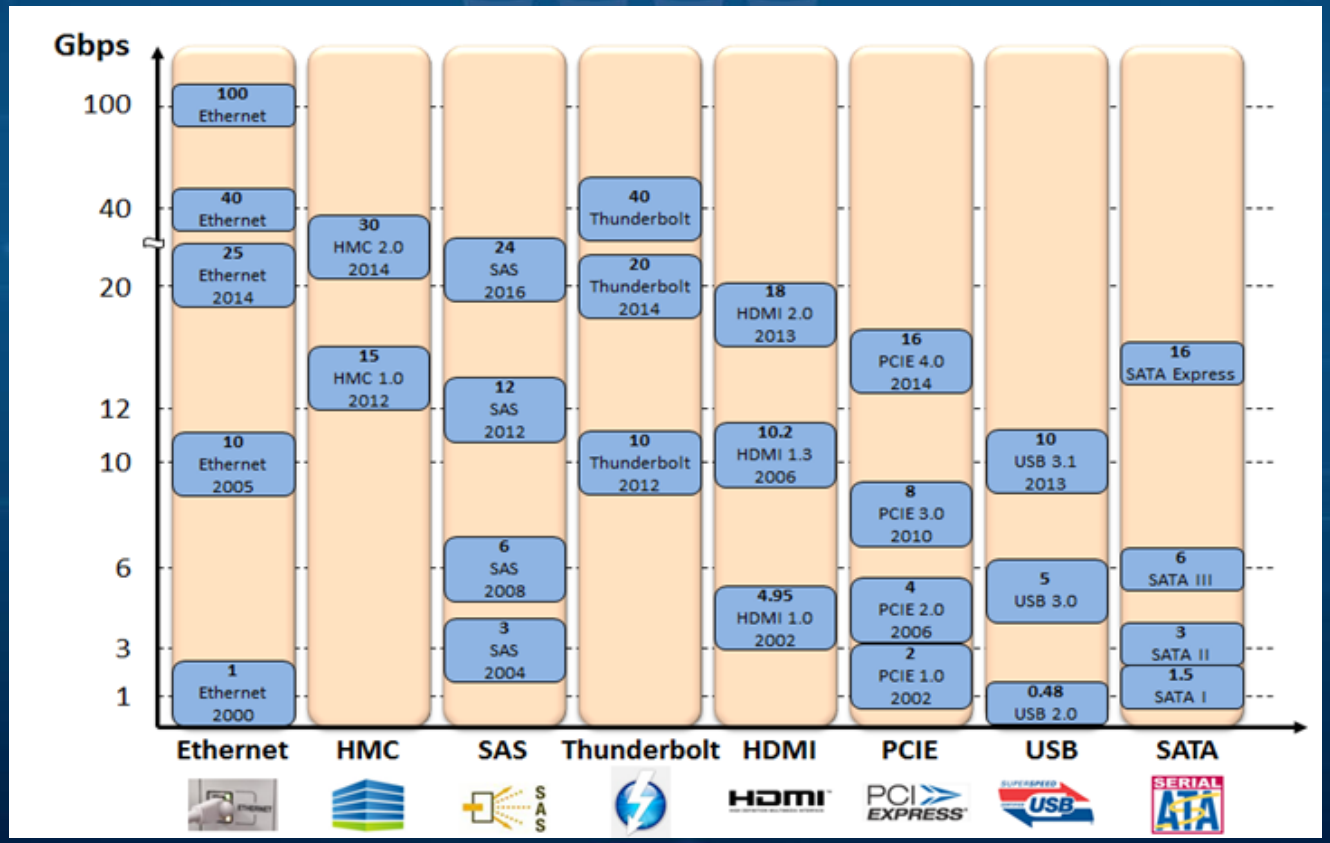
Agenda

- Background
- Introduction
- Electrical Performance
- Design of Taguchi Methods
- Experiment Validation
- Conclusion

Background

- There are several types of high-speed transmission interface which are shown at chart below. In order to achieve the required speed on the wafer level testing, the demand of the advanced loopback design is certainly more and more important.

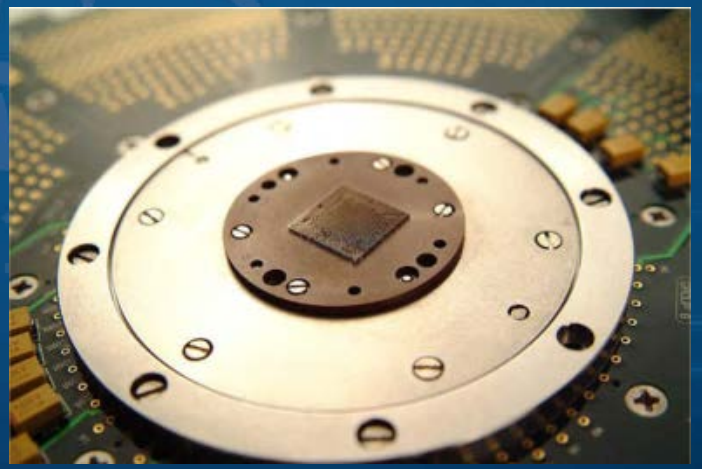


Background

- How to improve the performance of the probe card

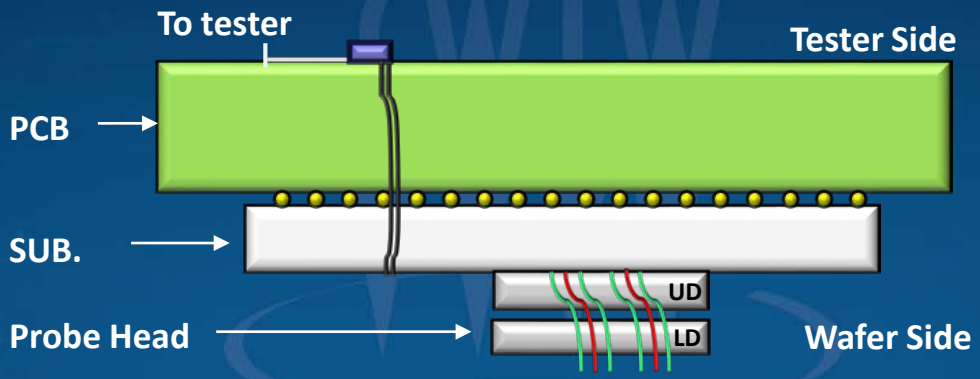
There are several factors, such as

1. PCB
2. SUB.
3. Needles

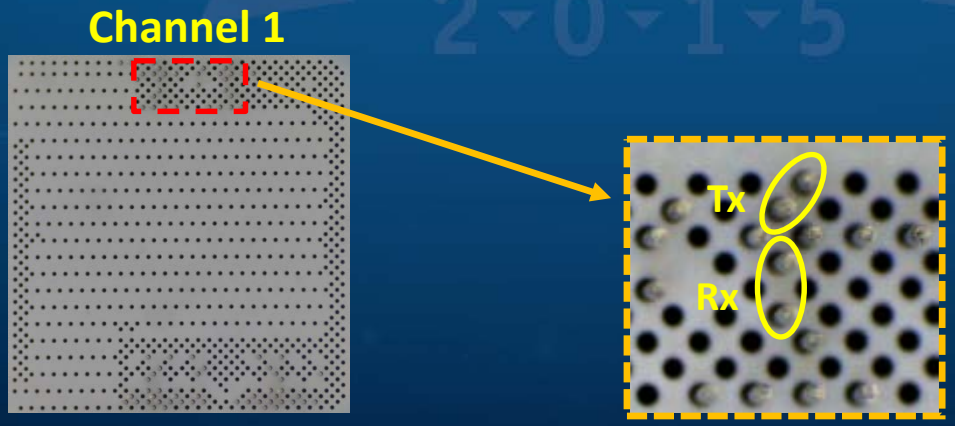


Background

- Conventional P/C



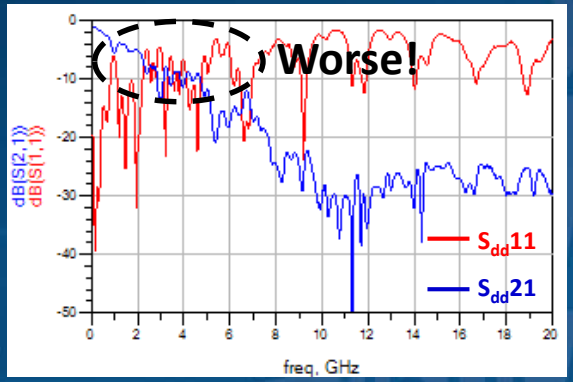
- I/O channel



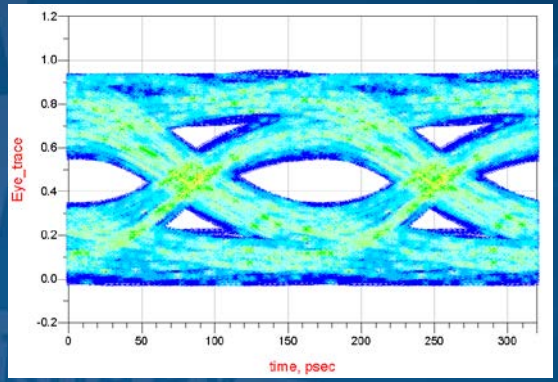
Background

- The channel1. of P/C measurement result and eye diagram

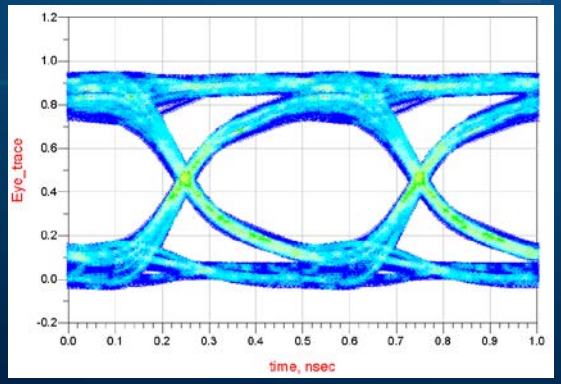
Channel 1.



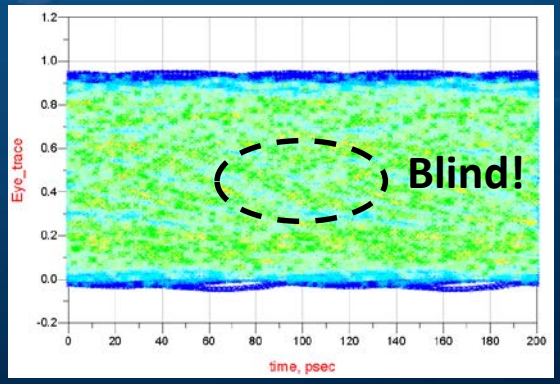
Channel 1. 6Gbps



Channel 1. 2Gbps



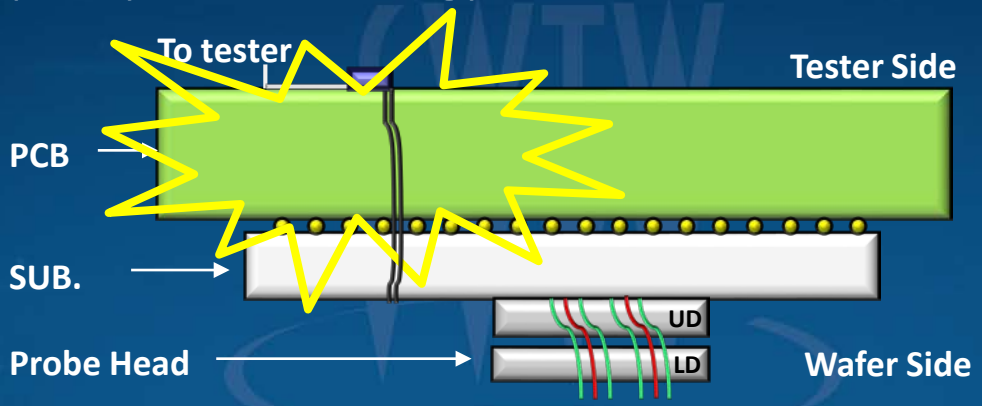
Channel 1. 10Gbps



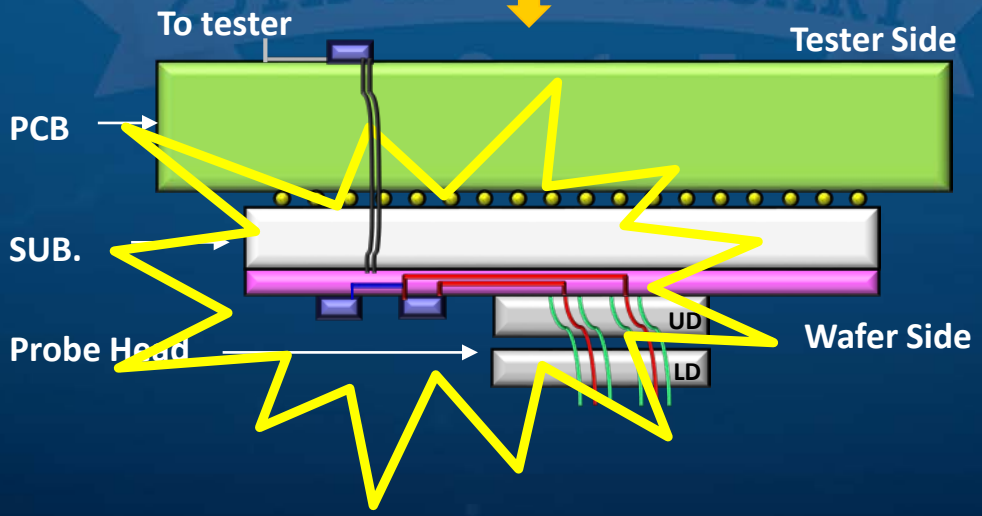
Introduction

- What is Super Eye ™ technology ?

Conventional P/C



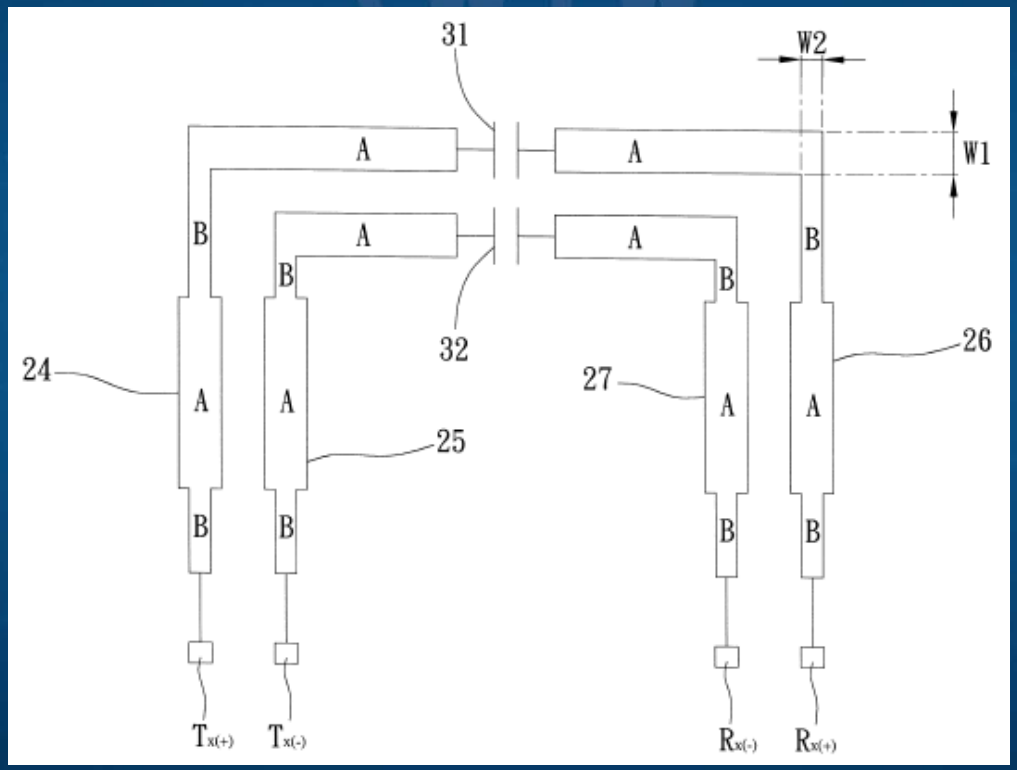
Super Eye ™ technology P/C



Introduction

- About Super Eye ™ technology

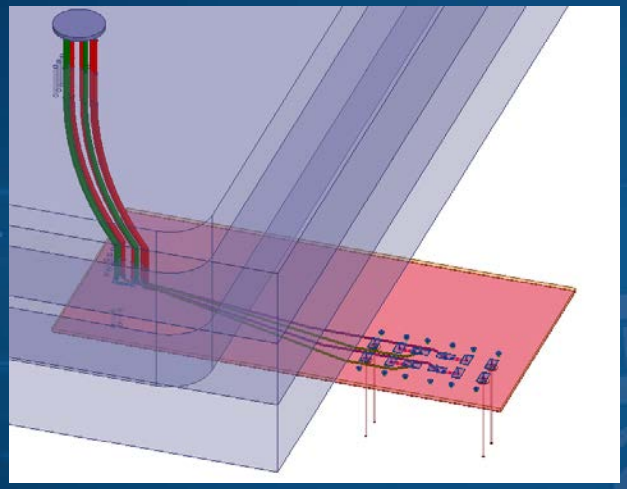
MPI design the impedance matching on the transmission line.



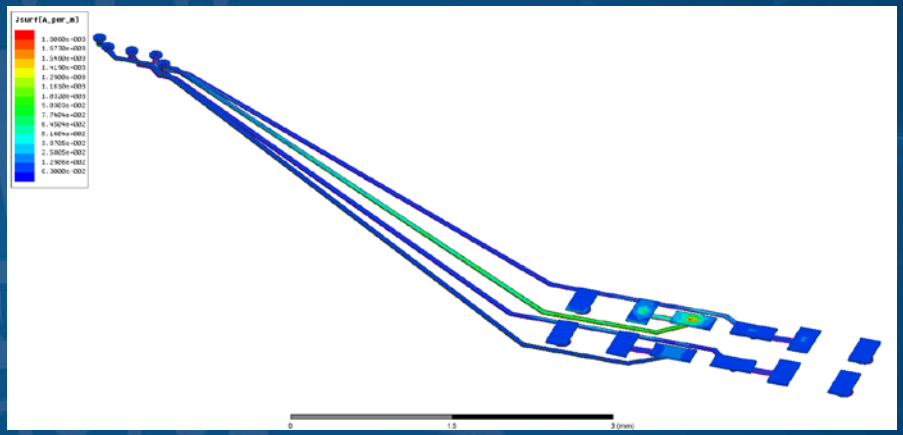
Super Eye ™ technology is patented and patents pending.

Electrical Performance (Sim.)

- By using 3D EM software and Super Eye ™ technology, it will help to progress the conventional electrical performance.

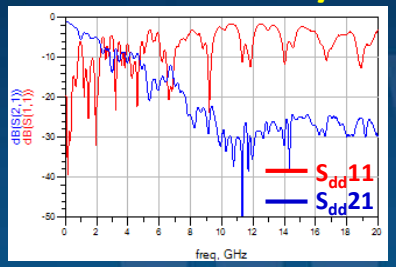
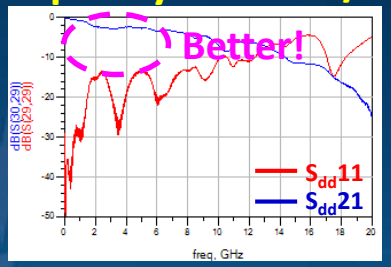
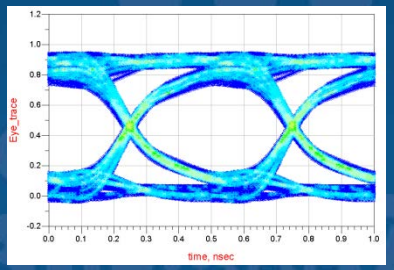
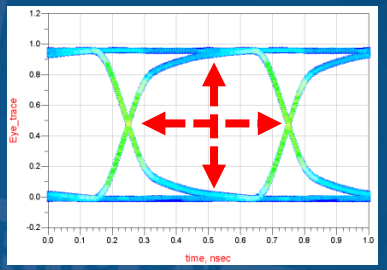
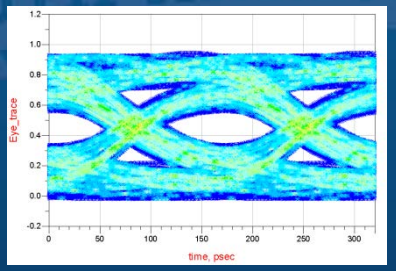
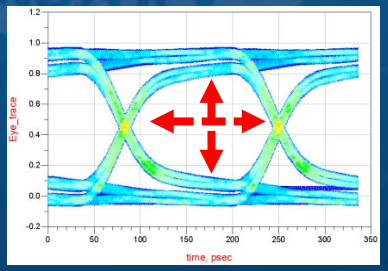
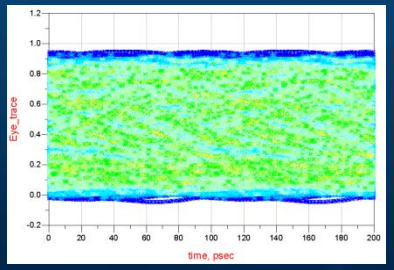
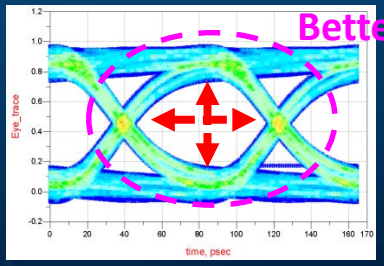


3D EM Design



Current Mag. Surf.

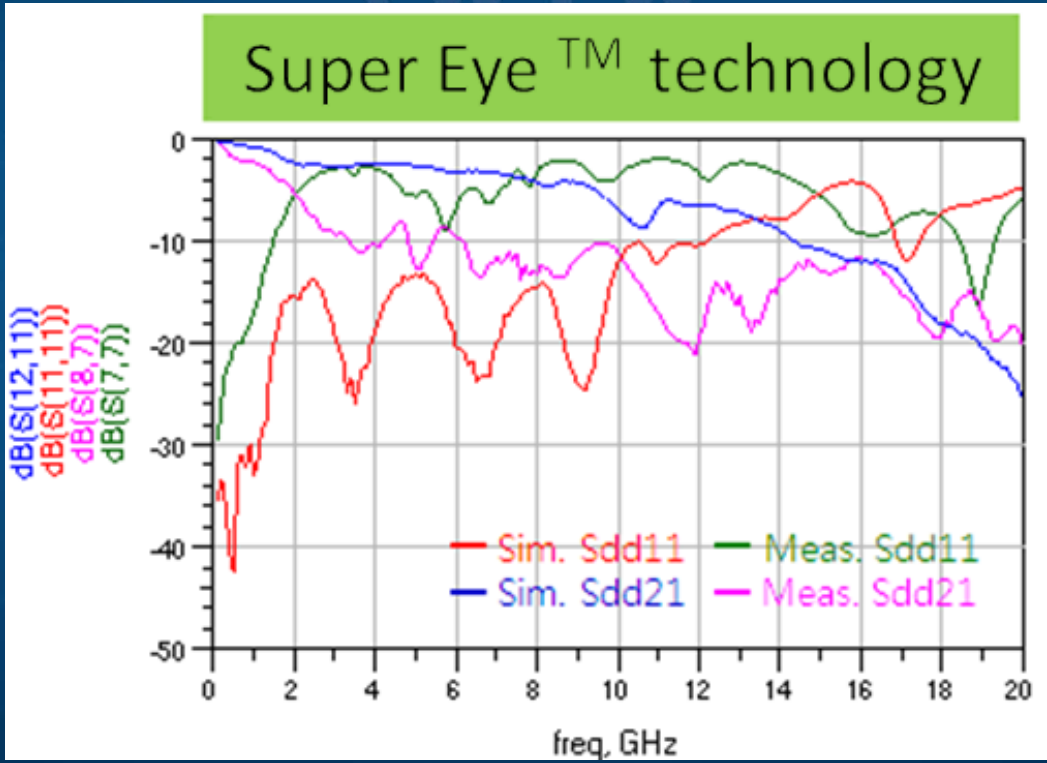
Electrical Performance (Sim.)

	Conventional P/C	Super Eye Tech. P/C
S21, S11		
2Gbps		
6Gbps		
12Gbps		

Electrical Performance

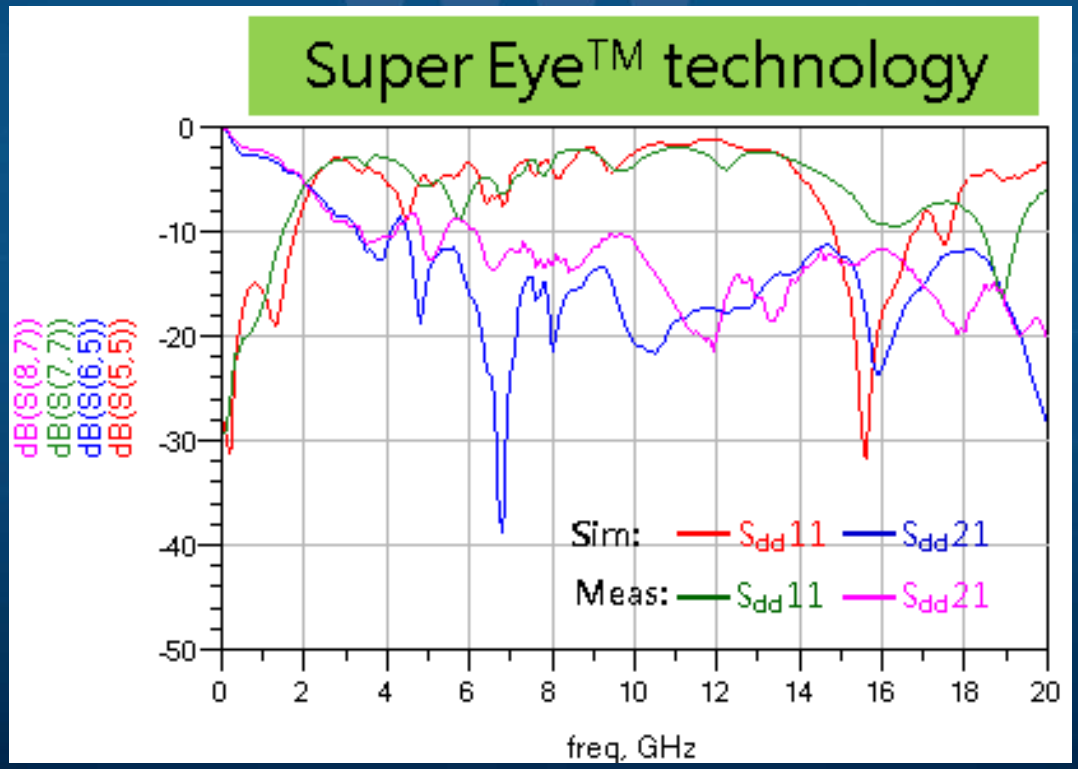
- Measurement result of P/C

The simulation and measurement results are inconsistent.



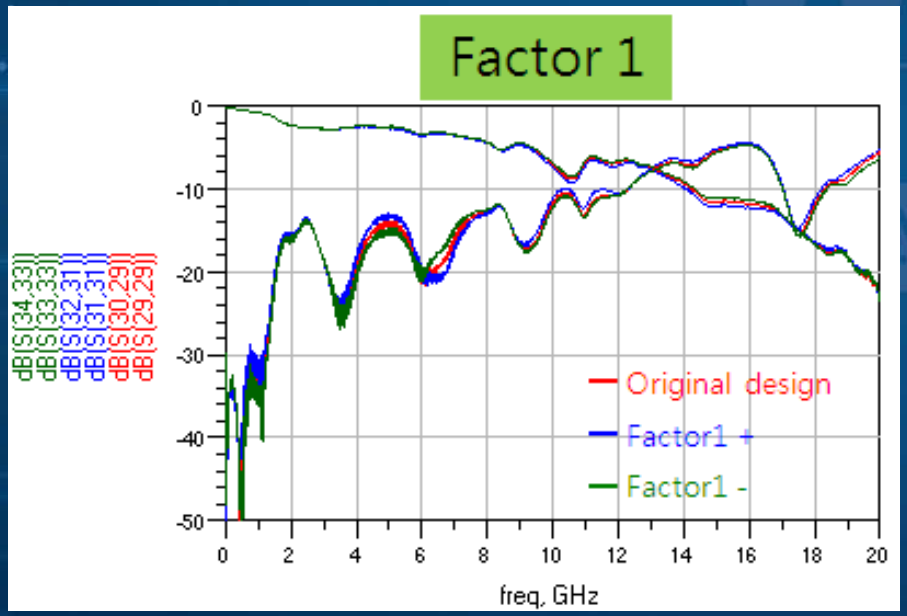
Electrical Performance

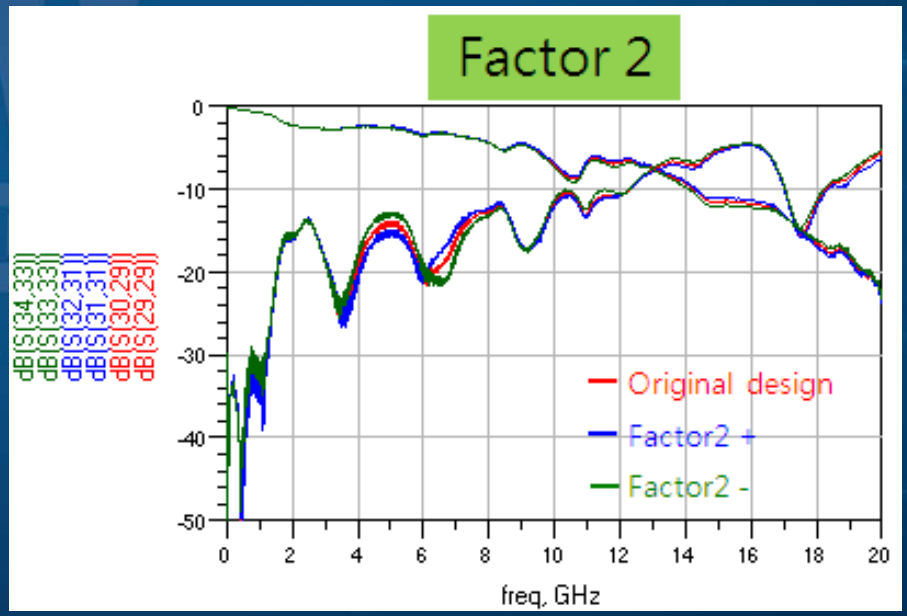
- There are several sensitive factors which cause the inconsistency between the measurement result and simulation. MPI analyzed those factors and made an improvement to the simulation resulting in more accurate results.



Design of Taguchi Methods

- We found 4 sensitive factors during the process of sensitivity analysis.





Design of Taguchi Methods

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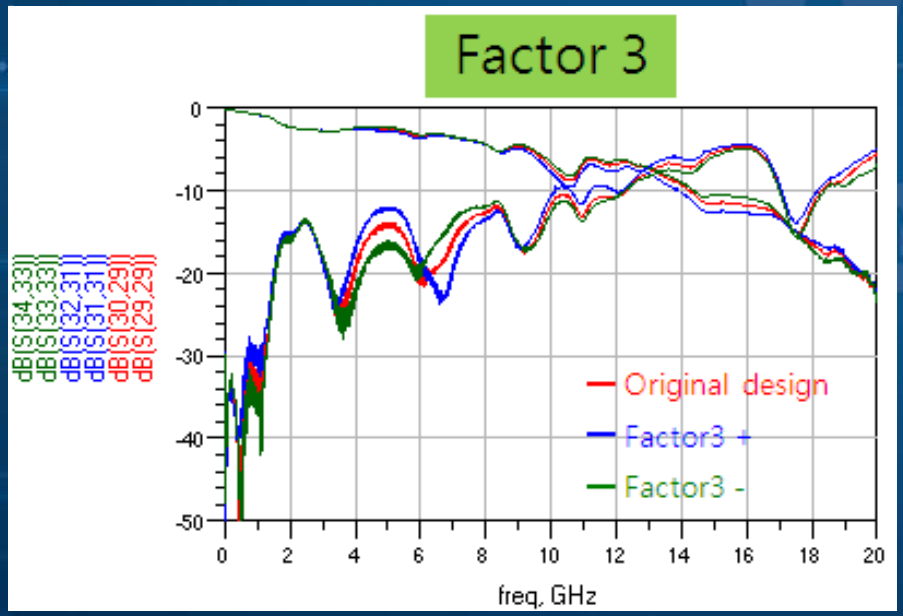
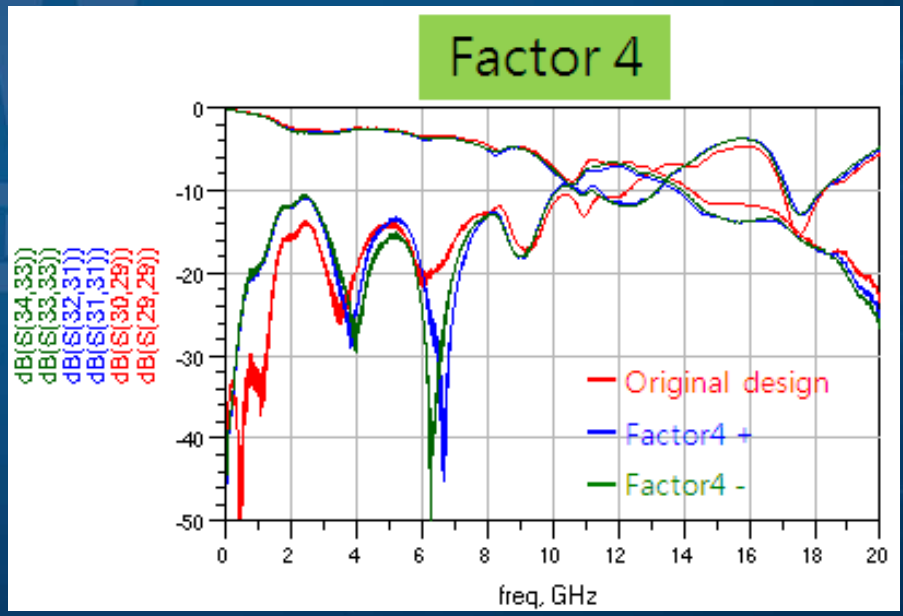
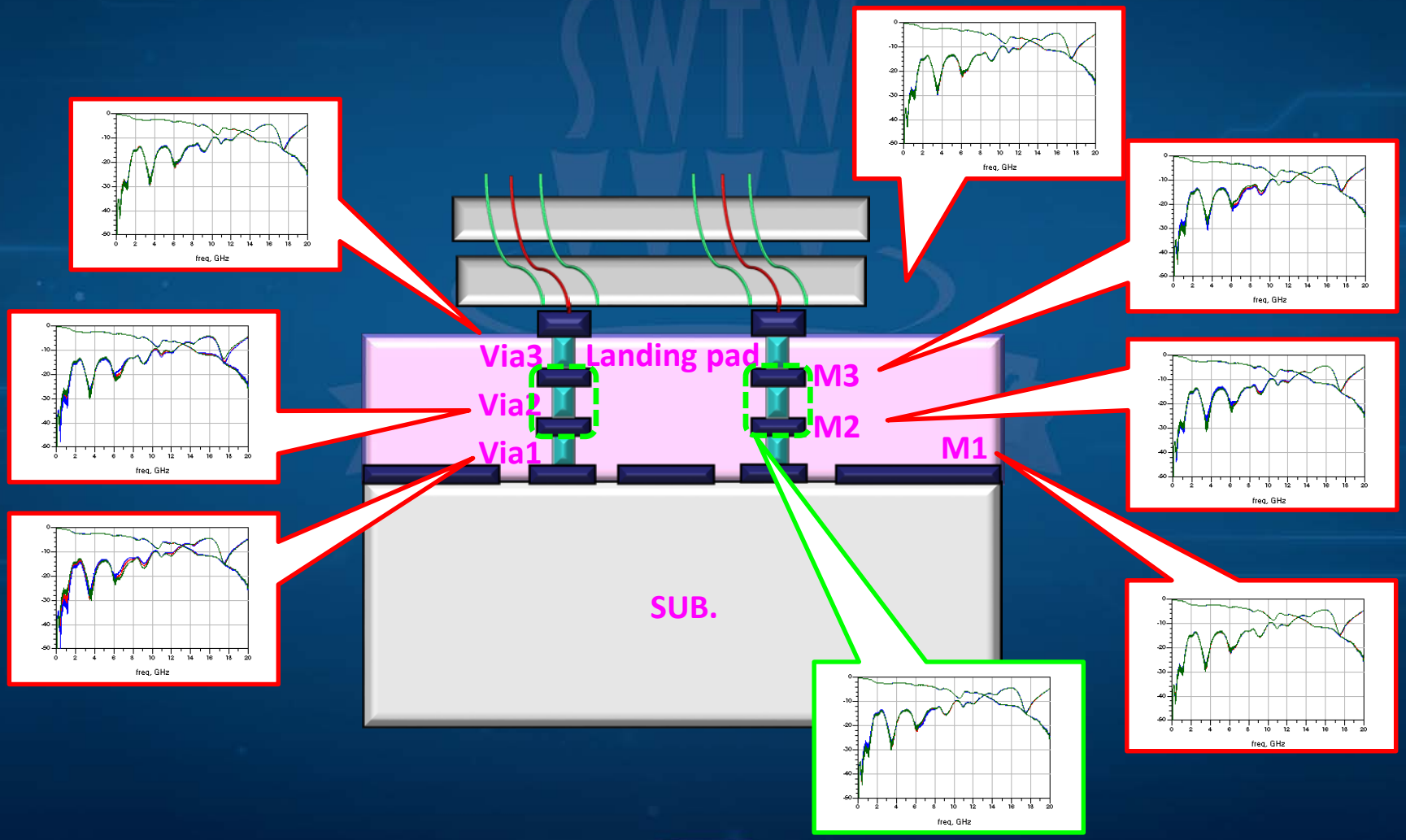




Design of Taguchi Methods

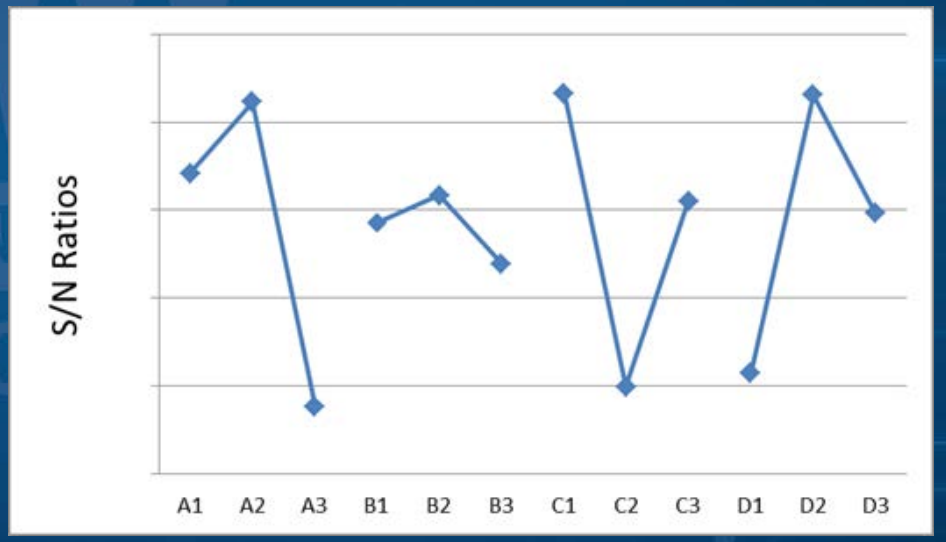
- Each sensitive factor might impact different Via, Metal, or landing pad.



Design of Taguchi Methods

- Taguchi Methods : Orthogonal Arrays & Experimental Data log, S/N Ratios.

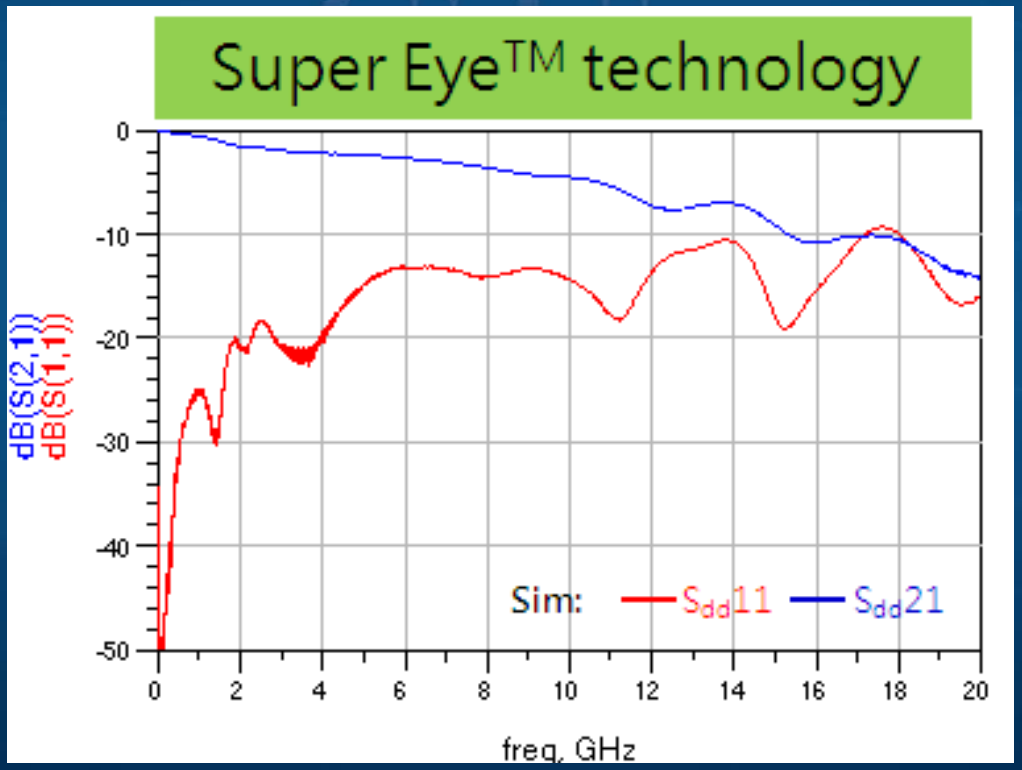
Experiment	A	B	C	D	S/N Ratios
1	1	1	1	1	
2	1	2	2	2	
3	1	3	3	3	
4	2	1	2	3	
5	2	2	3	1	
6	2	3	1	2	
7	3	1	3	2	
8	3	2	1	3	
9	3	3	2	1	



Design of Taguchi Methods

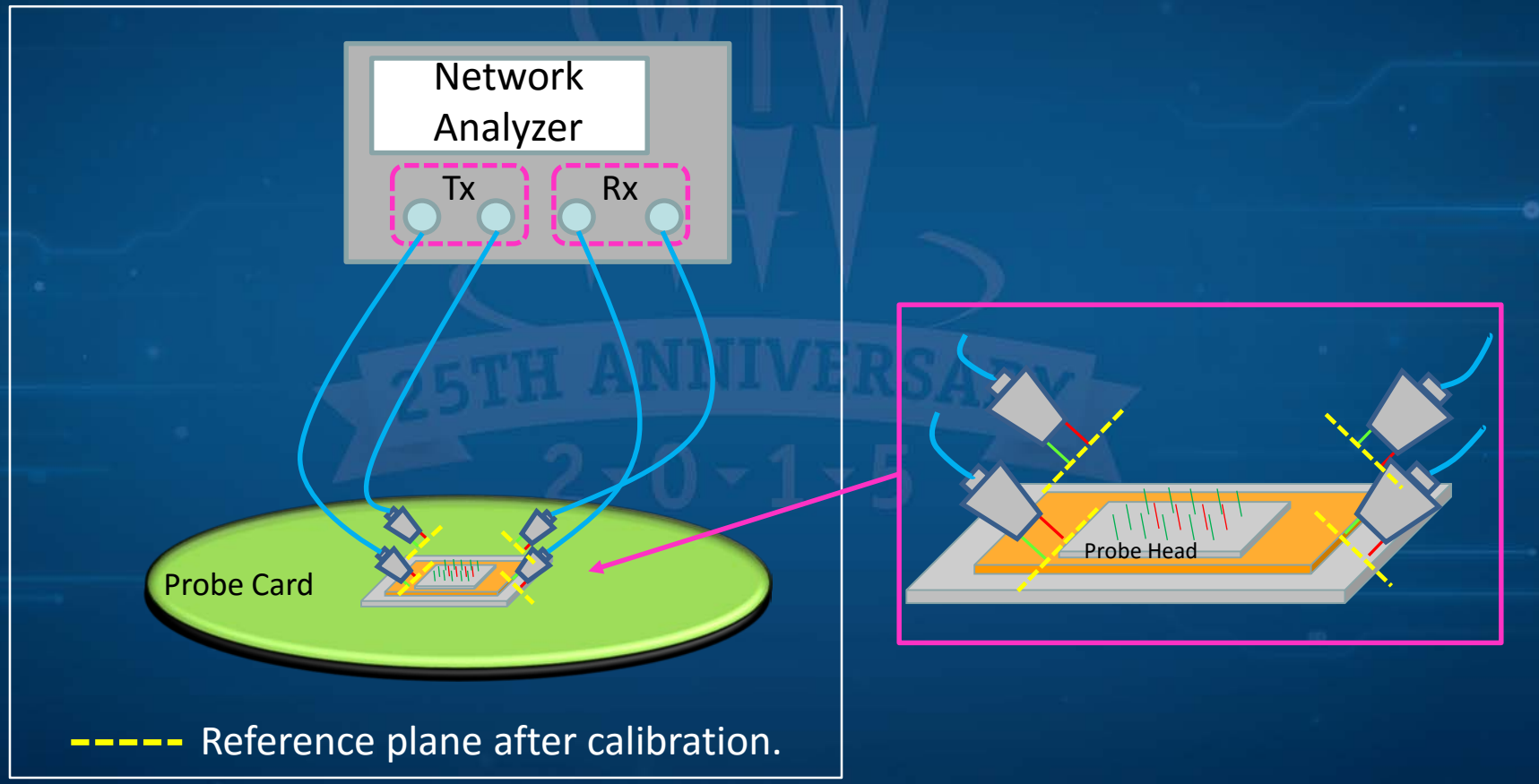
- Analysis Result

According to the sensitive factors, we use Taguchi Methods to improve the design and let the performance better.



Experiment Validation

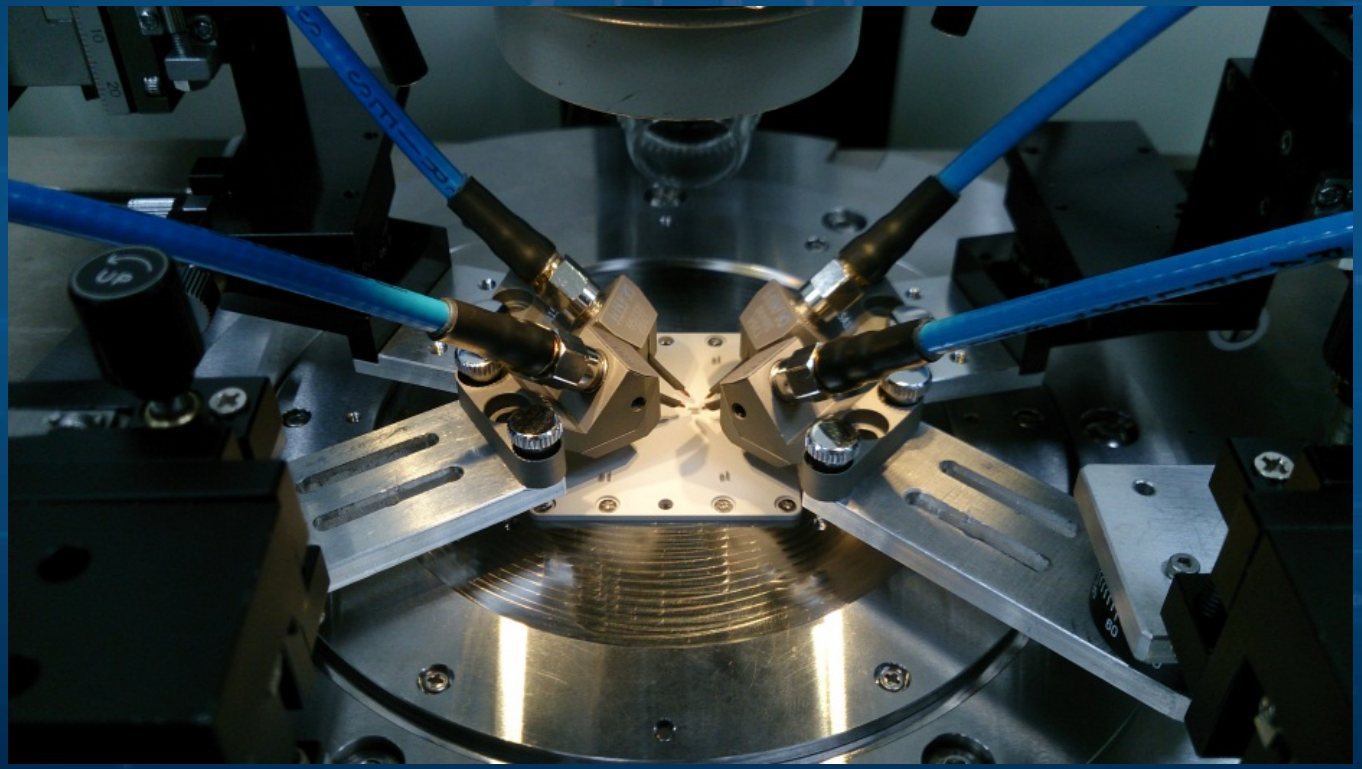
- Measurement system



Experiment Validation

- Measurement system

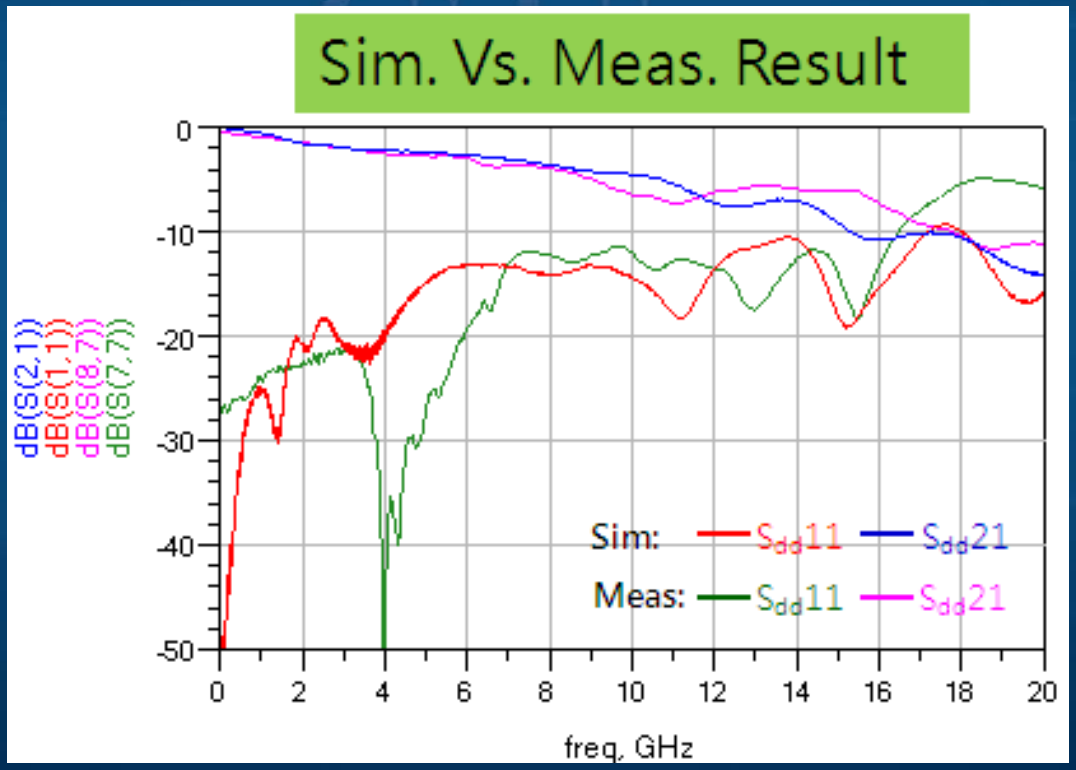
We adopted SOLT calibration method and de-embedded each probe to generate measurement result.



Experiment Validation

- Measurement result

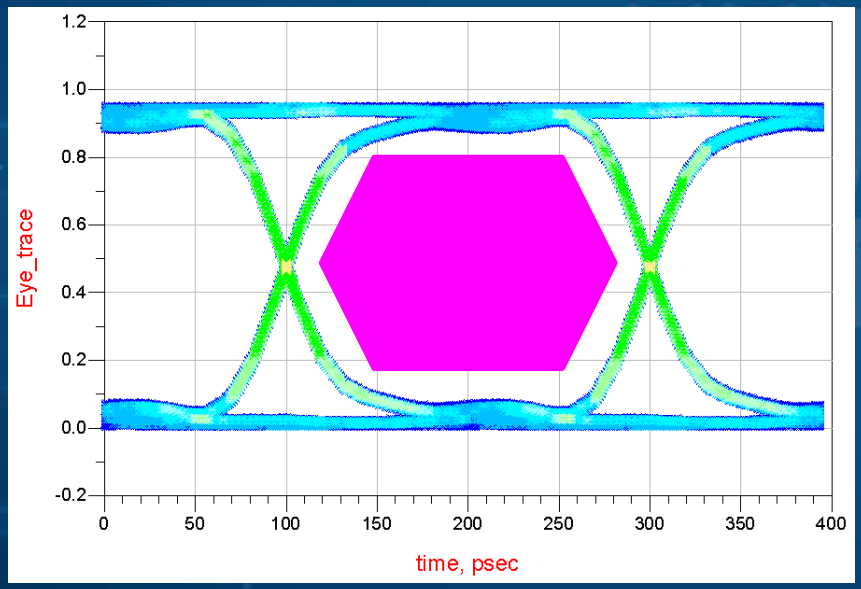
The measurement result shows the characteristics are improved.



Experiment Validation

- Eye diagram of 5 Gbps

Super Eye ™ 5Gbps

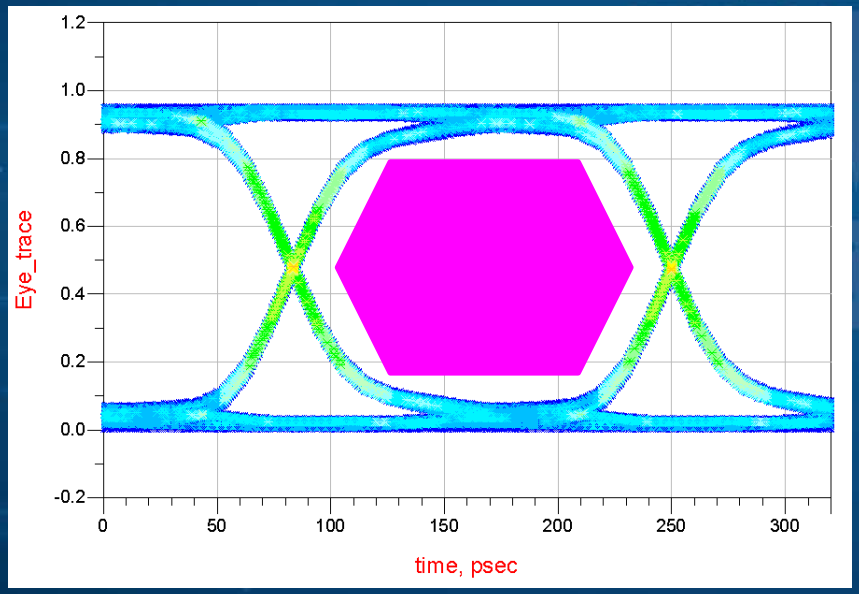


Rise/Fall time = 50 ps
Data rate = 5 Gbps
Data type = PRBS(2^{32}-1)
Vo/Vi *100% = 74%

Experiment Validation

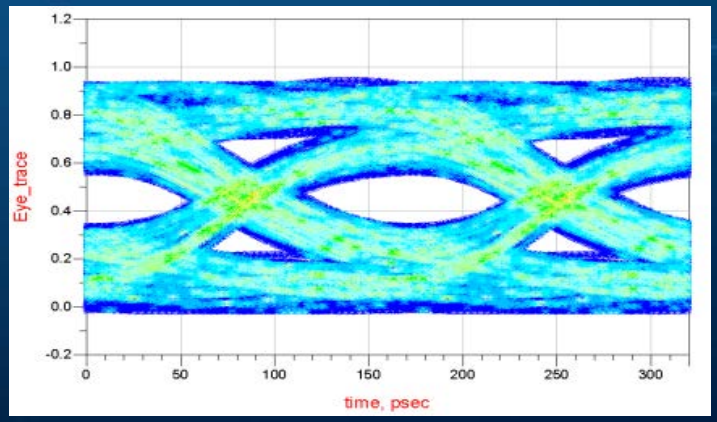
- Eye diagram of 6 Gbps

Super Eye ™ 6Gbps



Rise/Fall time = 41.667 ps
Data rate = 6 Gbps
Data type = PRBS(2^{32}-1)
Vo/Vi *100% = 72%

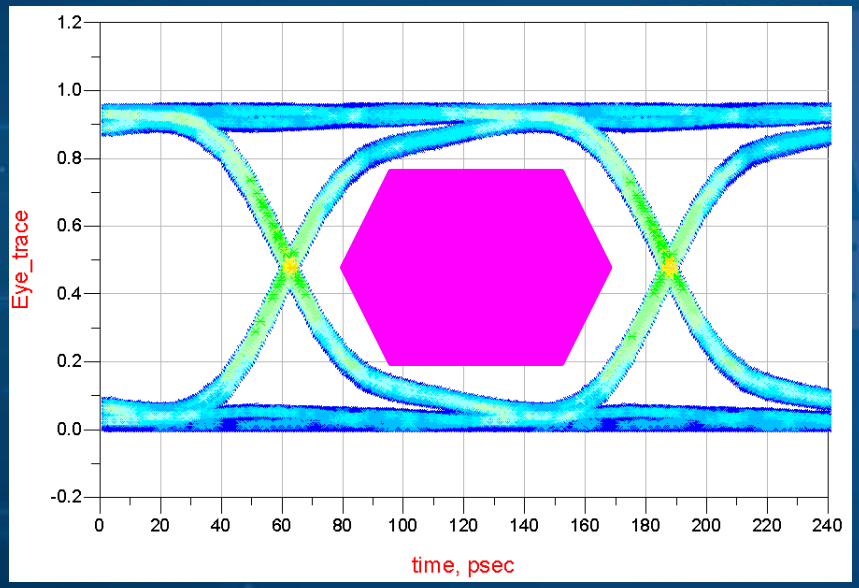
Conventional P/C 6Gbps



Experiment Validation

- Eye diagram of 8 Gbps

Super Eye ™ 8Gbps

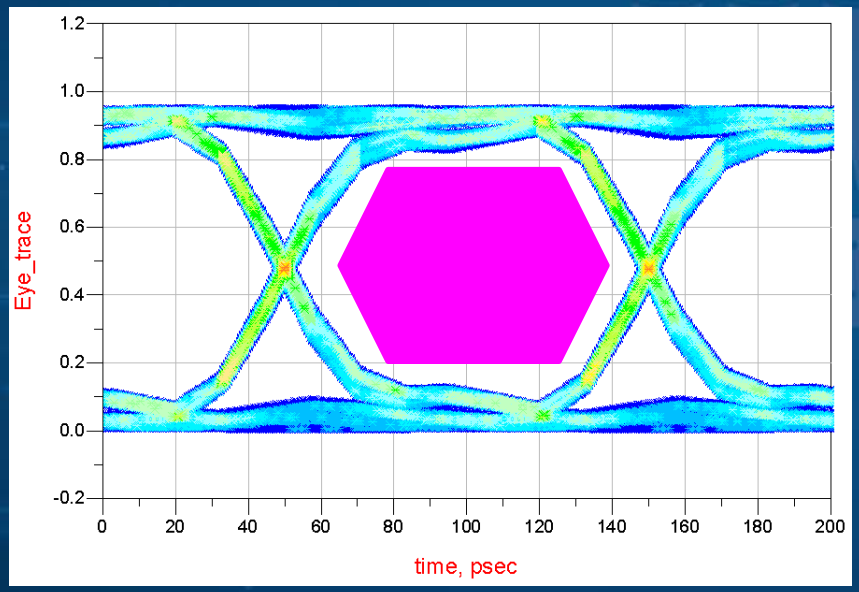


Rise/Fall time = 31.25 ps
Data rate = 8 Gbps
Data type = PRBS(2^{32}-1)
Vo/Vi *100% = 66%

Experiment Validation

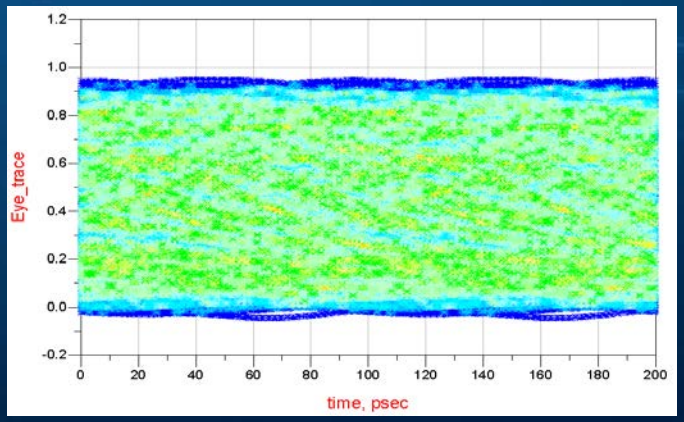
- Eye diagram of 10 Gbps

Super Eye ™ 10Gbps



Rise/Fall time = 25 ps
Data rate = 10 Gbps
Data type = PRBS(2^{32}-1)
Vo/Vi *100% = 64%

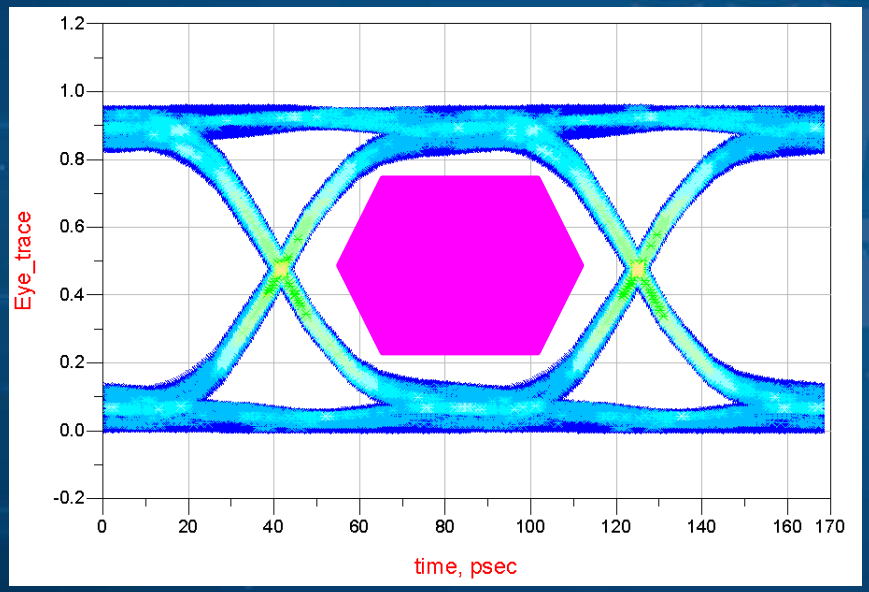
Conventional P/C 10Gbps



Experiment Validation

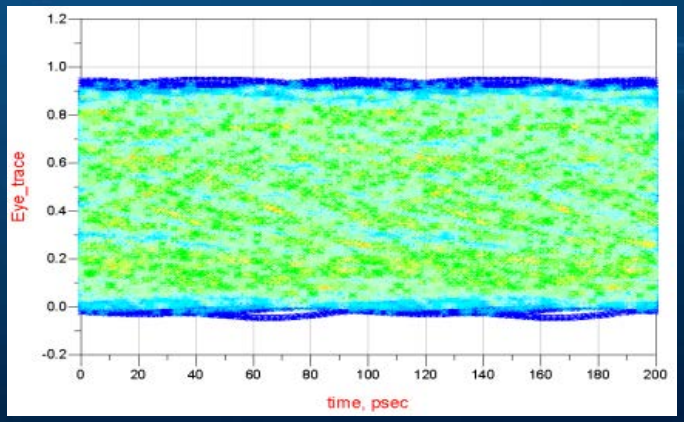
- Eye diagram of 12 Gbps

Super Eye ™ 12Gbps



Rise/Fall time = 20.8 ps
Data rate = 12 Gbps
Data type = PRBS(2^{32}-1)
Vo/Vi *100% = 60%

Conventional P/C 12Gbps



Conclusion

Super Eye ™ technology

1. Super Eye ™ technology can support 12Gbps for vertical probe card loopback application on high speed transmission interface (USB3.0: 5Gbps, SATA3: 6Gbps, PCI-E 3.0: 8Gbps, Ethernet: 10Gbps…etc.).

2. Improve conventional loopback design: Impendence matching on the transmission line to improve electrical performance.

Acknowledgements

Special thanks

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(MPI)

Y. S. Kuo , Kenny Tang

(tsmc)

Thank you

Q & A

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