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Root cause analysis for probe mark control

• **Author Details**

CHAO WEN CHIANG
CHIA WEI CHEN
SHU JENG YEH
MIN CHANG TU
JYUN HAO LIN
LING CHUN FANG

Presenters' Biography

CHAO WEN CHIANG

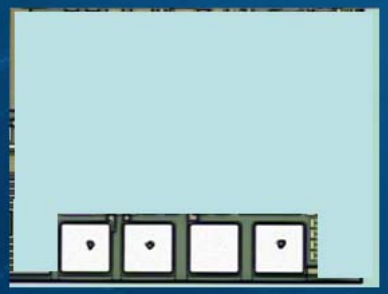
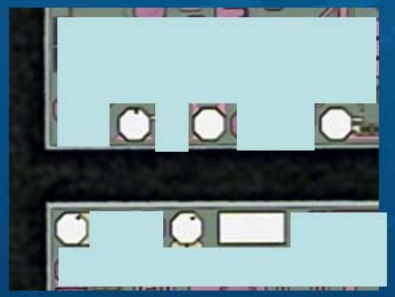
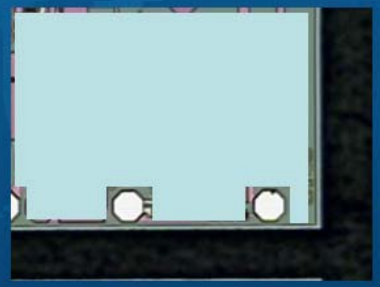
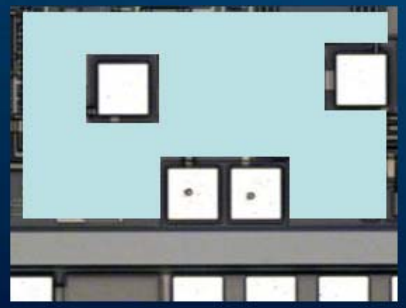
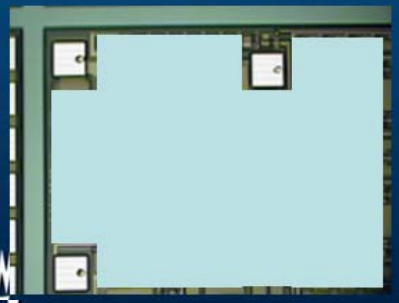
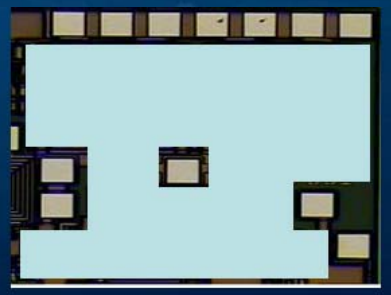
- Master degree in mechanical engineering from Chang-Gung University , Taiwan, 2004
- 2006 join the WIN semiconductor Corp.
- Major in WAT and visual inspection to improve testing.

CHIA WEI CHEN

- Master degree in electrical engineering from National Central University, Taiwan, 2006
- 2007 join the WIN semiconductor Corp.
- Major in the 100% wafer probing both on DC and RF testing.

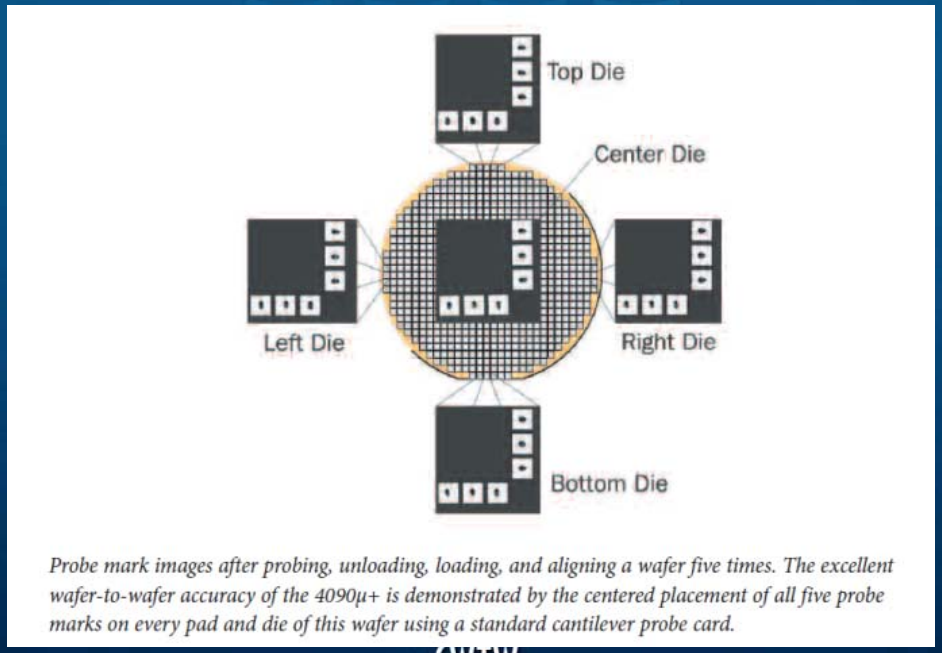
Introduction / Background

- We are belong to the wafer testing division from WIN semiconductor foundry.
- Probe mark uncertainties of thin GaAs wafer are major problems that we met and result in wafer scrap.
- The following photos show the result between pass and NG.

Pass	NG		
			
			

Idea inspiration

- In order to maintain the good probing service, we regularly check the probe mark to look for bad probers in advance, but it is decided by HVI (Human visual inspection) in our Fab production line.
- However, the HVI sometimes is not reliable.
- Now, we implement an AVI (Auto visual inspection) to the routine to minimize the human mistake and easier to analyze the failure modes .



Probe mark images after probing, unloading, loading, and aligning a wafer five times. The excellent wafer-to-wafer accuracy of the 4090μ+ is demonstrated by the centered placement of all five probe marks on every pad and die of this wafer using a standard cantilever probe card.

Example : EG4090

Objectives / Goals

- The misalignment of probe mark has an important impact on wafer probing quality and throughput.
- We would like to check characteristics of probe mark for the purpose of analysis.
- Probe mark is a direct indication and a key point to express how well the prober works, therefore, the inspection to check probe mark is an essential procedure to wafer probing house. To distinguish misalignment from prober, thin wafer or operation is the main idea of our objective.
- It conducts accuracy and cycle time of foundry testing service well.

Methods (1/2)

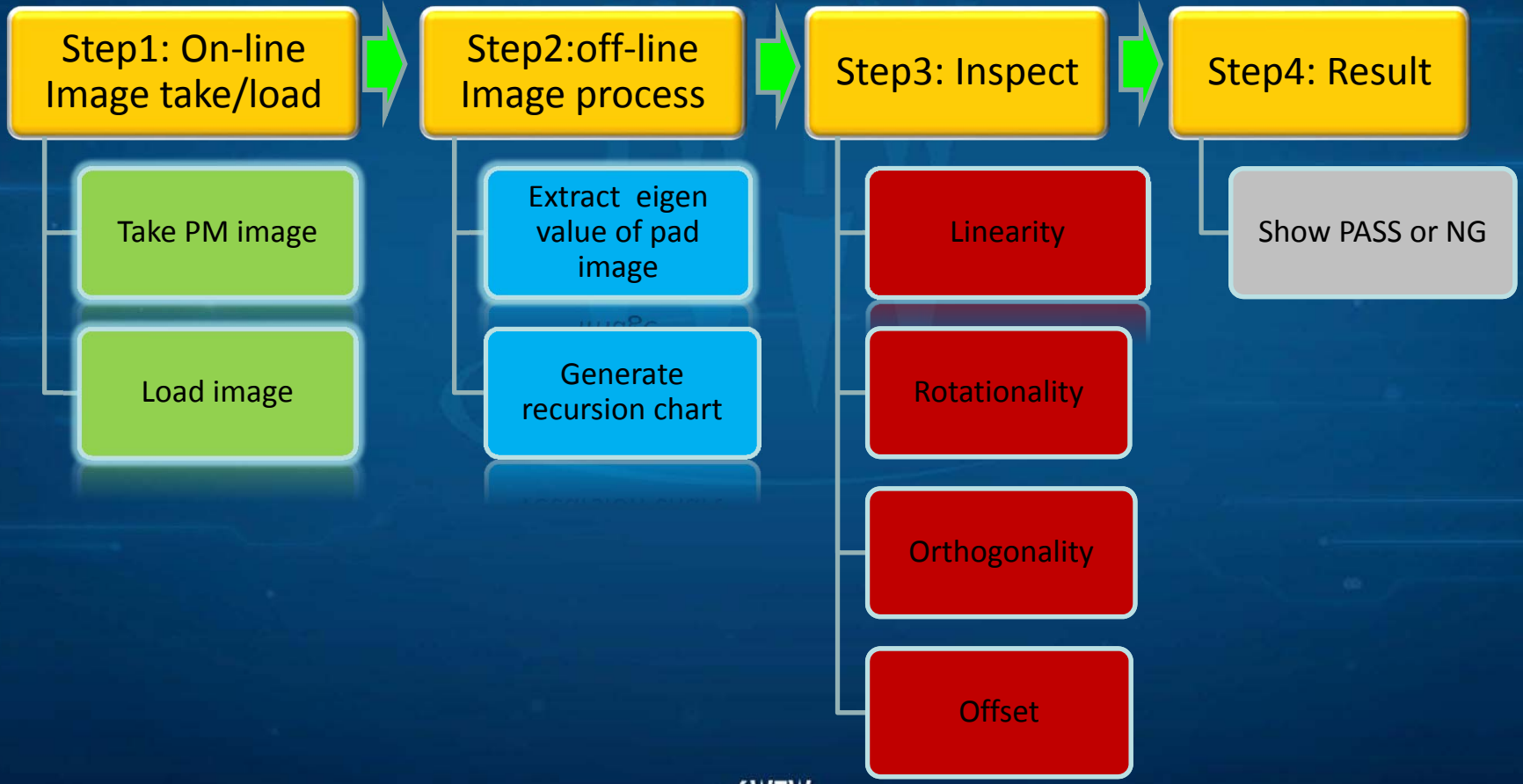
- In this presentation, we will demonstrate how this wafer probe mark inspection check system that can analyze these probe mark failure modes (Linearity, Rotation, Orthogonality, and Offset) of prober to improve our wafer probing quality and prober utilization rate.
- A probe card and a wafer are necessary. We will take pad image of one die per reticle from both the X-axial and Y-axial. Based on the image, it will be processed by LabView program to arrange a recursion chart and pull out the region of interest to analyze the root cause of probe mark misalignment.

Methods (2/2)

- The analysis purpose includes two categories, one is to distinguish failure modes and the other is to do periodically quality check. According to analysis results, it can tell us the misalignment is from prober or operation.
- Four parameters as below are extracted from recursion chart.
  1. Linearity : linear movement of X-axial and Y-axial.
  2. Rotationality : theta rotation of X-axial and Y-axial.
  3. Orthogonality : Orthogonal correlation of X-axial and Y-axial.
  4. Offset : probe mark position correctness over whole wafer.

Procedure

- **The inspection procedure is shown as below,**

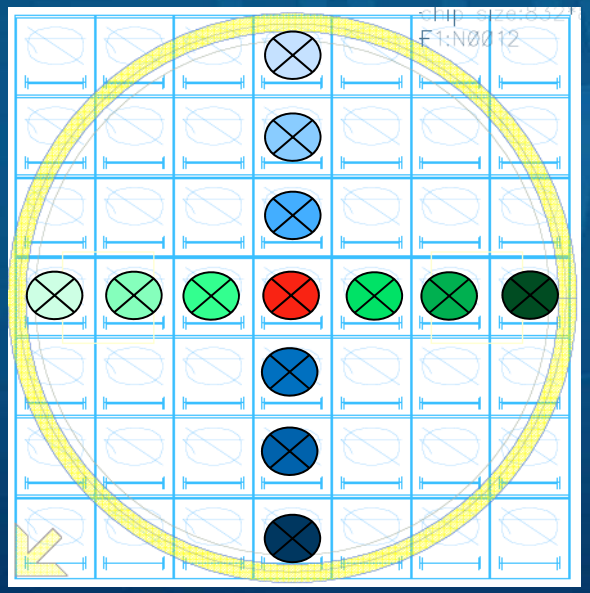


Procedure-Step1

- **The first step is to take picture at the specific location from wafer by both X-axial and Y-axial .**
- **We select 13 reticles to analyze the performance of prober.**

Step#1: On-line Image take/load

- Take PM image
- Load image



• Wafer Map

• Image folder

Procedure-Step2

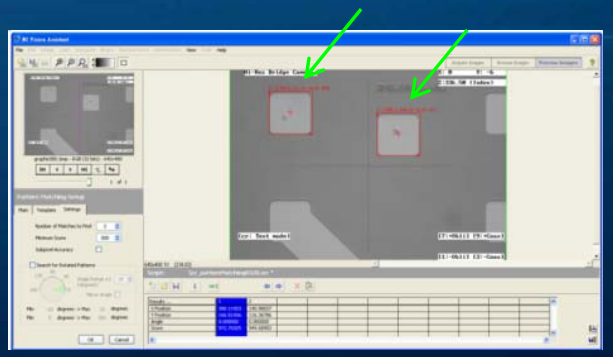
- **We will extract only pad image from the previous store folder, and arrange them to a new chart, called “recursion chart”.**
- **We use pattern matching method to pull out the pad we need.**

Step#2:off-line Image process

- Extract image of pad
- Generate recursion chart

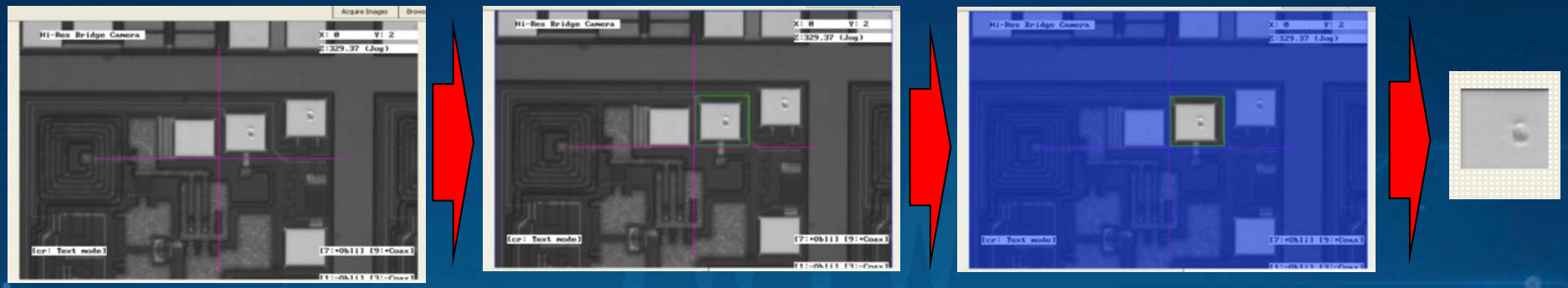
• Golden pattern

•Pattern matching result

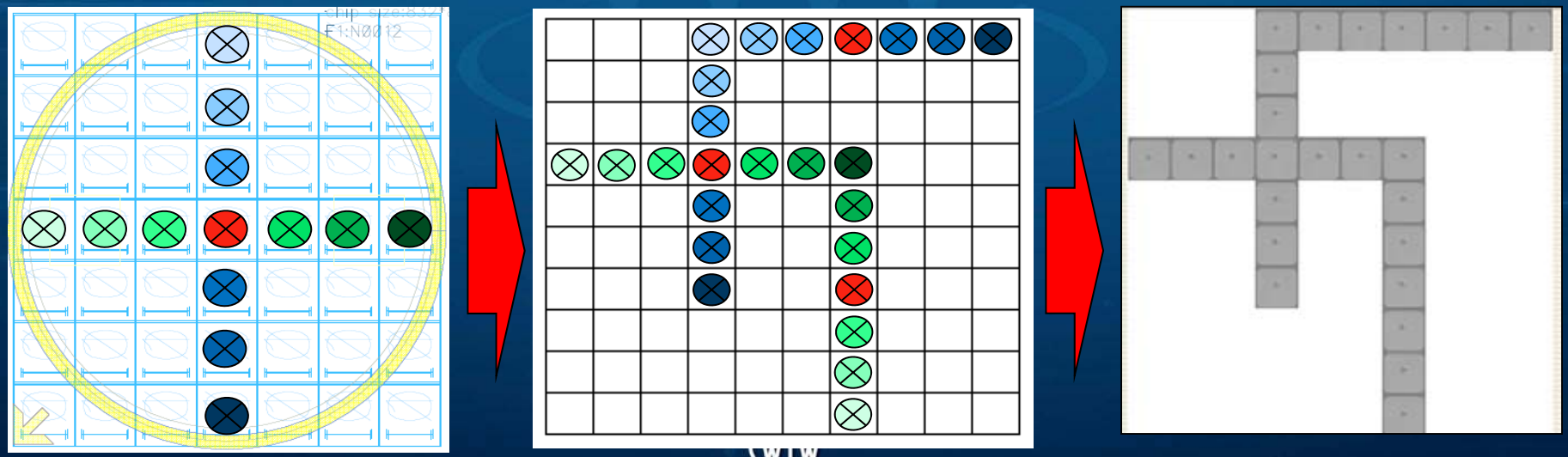


Procedure-Step2 (Cont'd)

- Based on the method, the pad image can be extracted correctly.



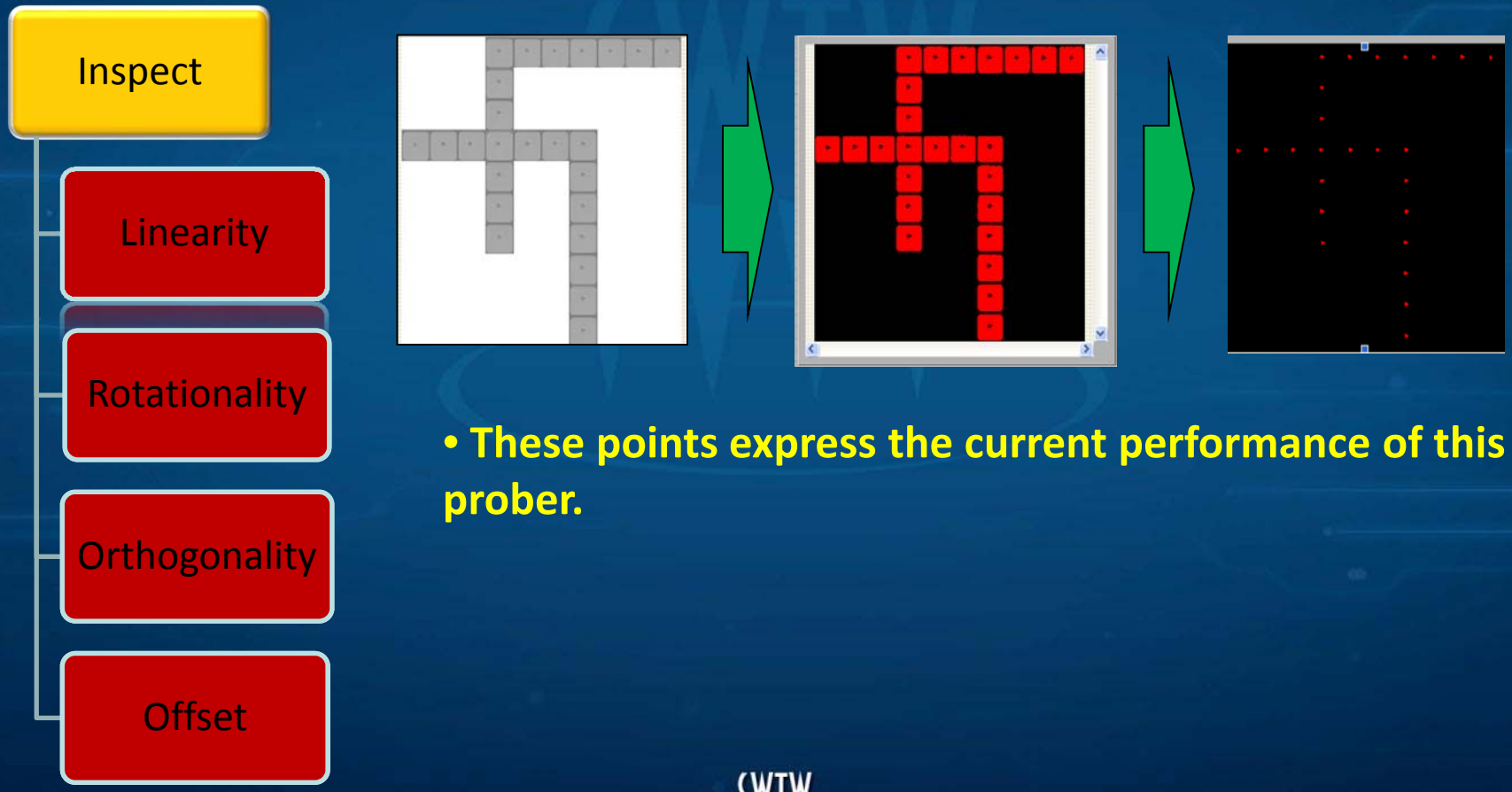
- Then, we can generate the recursion chart after finishing extraction from these pictures. This chart consists of the pad from both X-axial and Y-axial.



Procedure-Step3

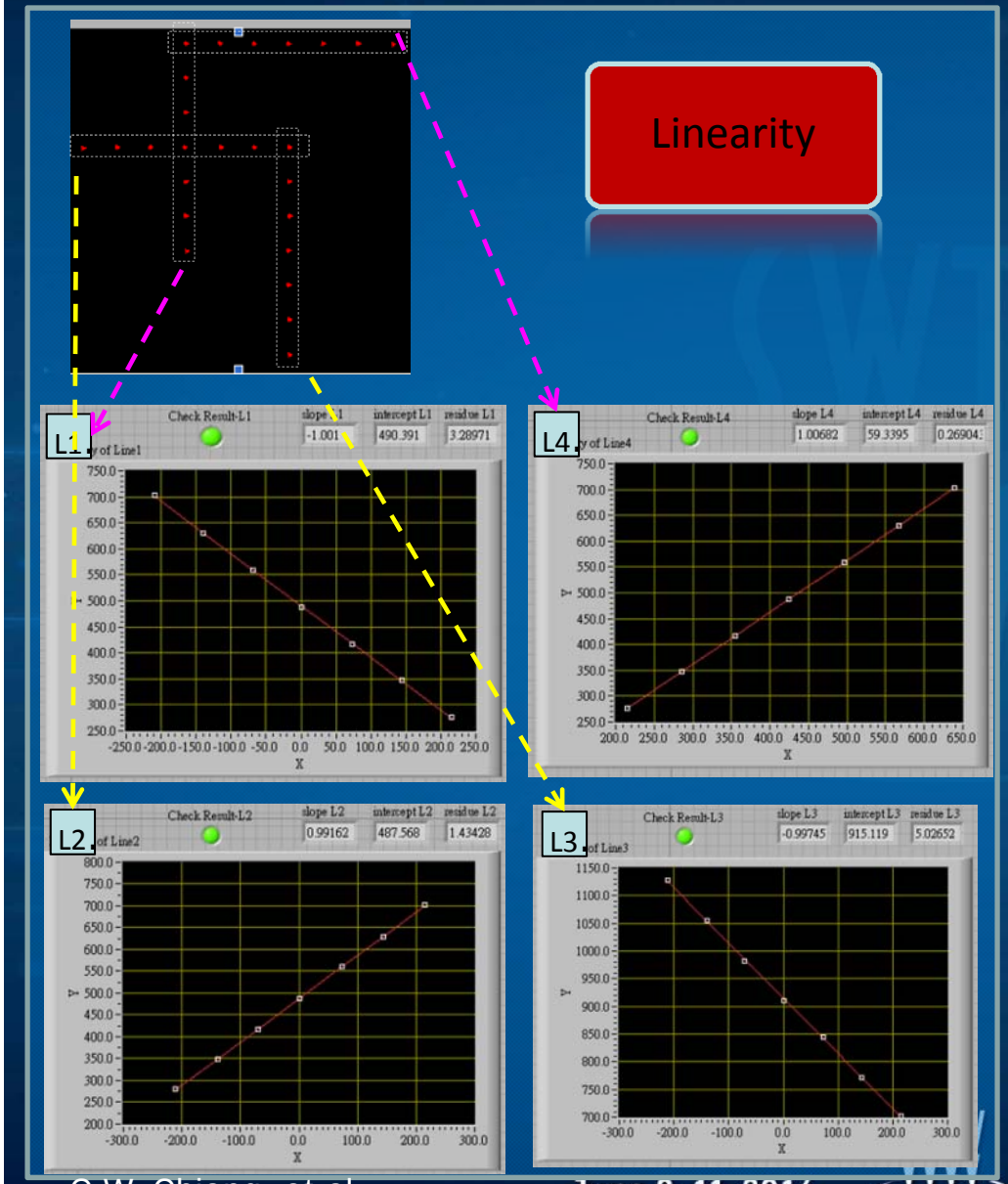
- **Four different criterions will be checked.**

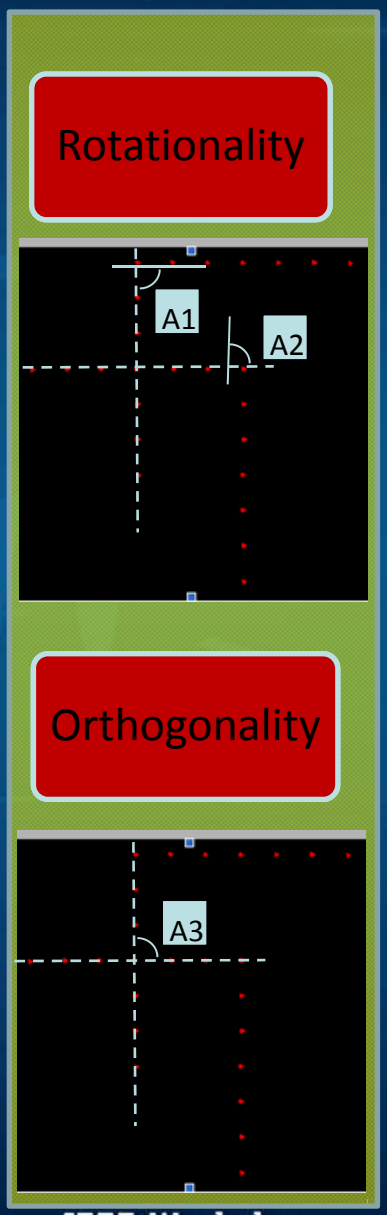
1. Linearity 2. Rotationality 3. Orthogonality 4.Offset

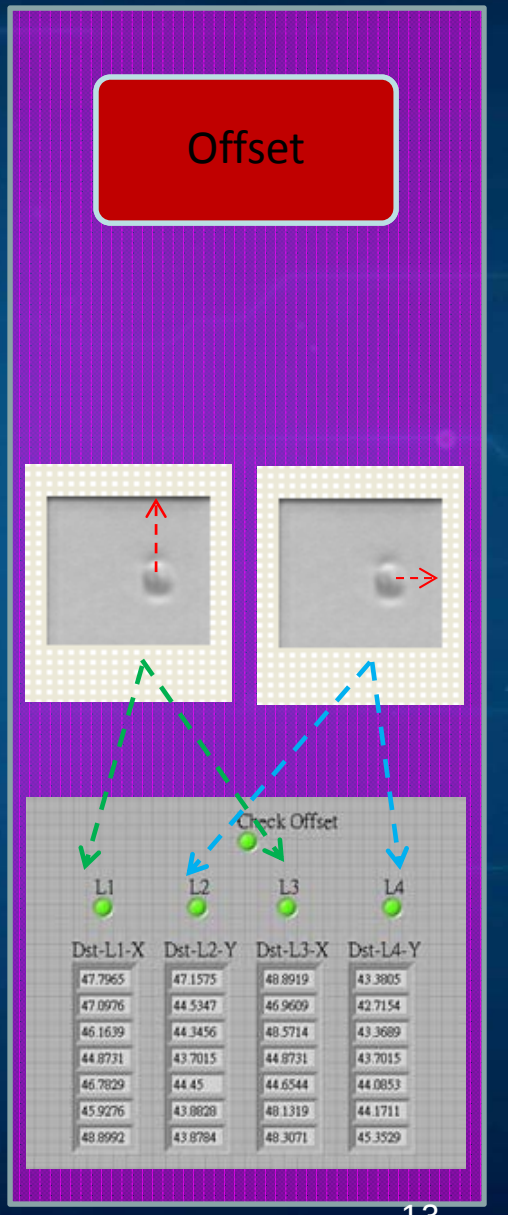


- **These points express the current performance of this prober.**

Procedure-Step3 (Cont'd)







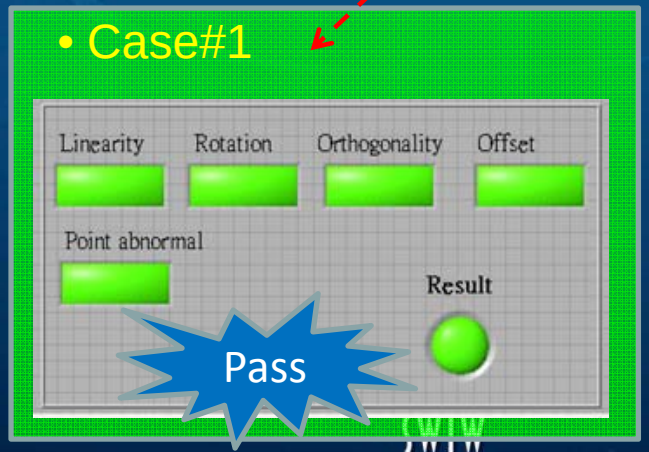
Procedure-Step4

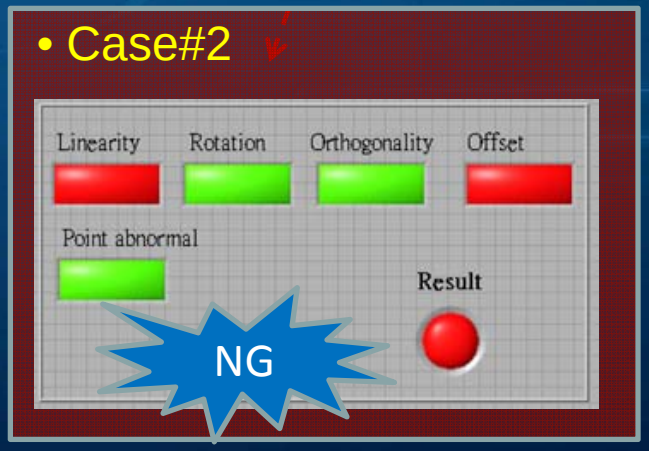
- **All result will be shown after checking.**

Step4: Result

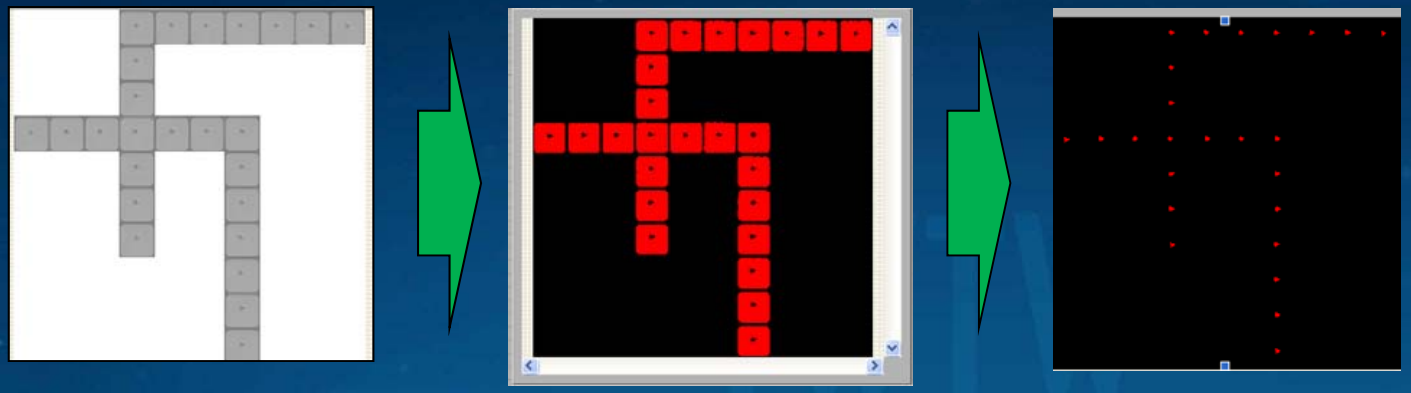
Show PASS or NG

Item	Category	SPEC	Case#1	Case#2
1	Linearity	Residue<10	Pass	NG
2	Rotationality	88<theta<92	Pass	Pass
3	Orthogonality	88<theta<92	Pass	Pass
4	Offset	40<offset<60	Pass	NG
5	Point count	Must be 25	Pass	Pass

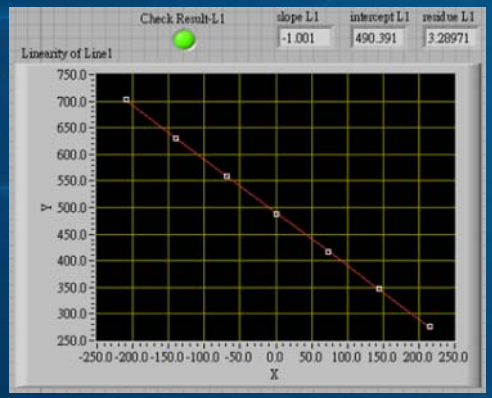


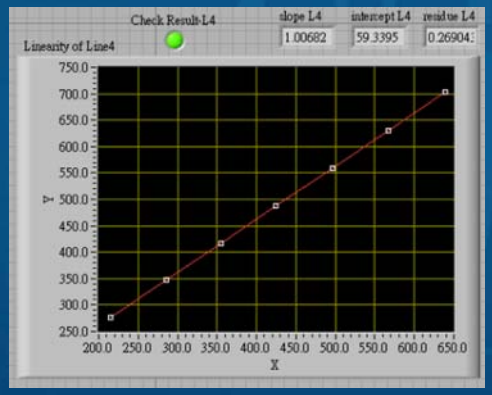


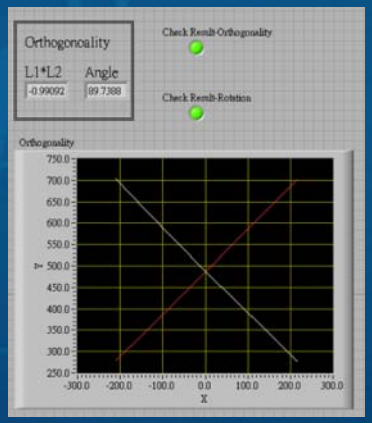
Result-case#1

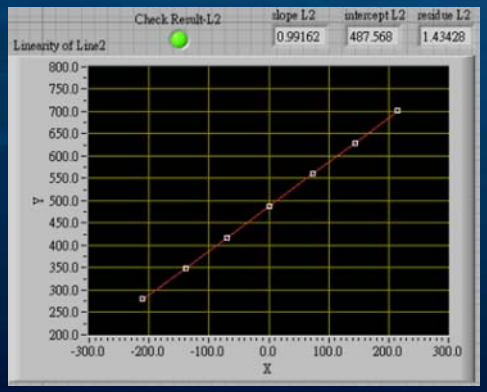


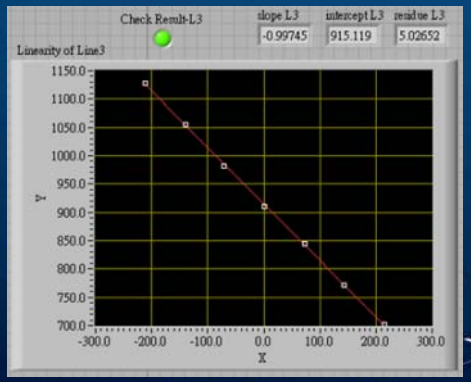
- Normal

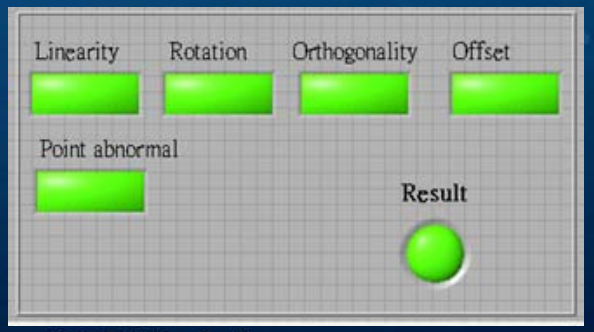




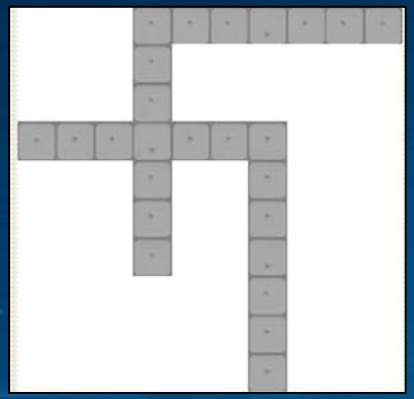


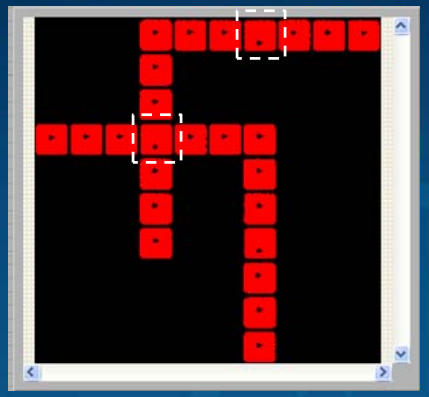


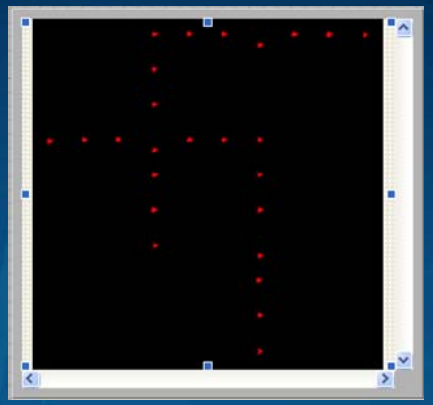




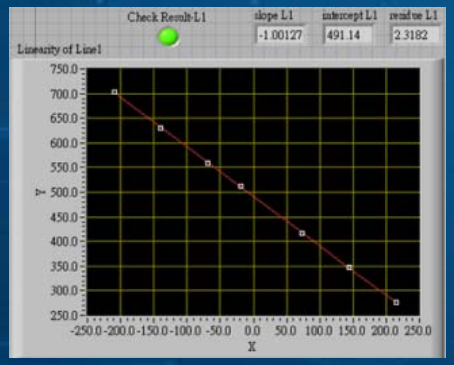
Result-case#2

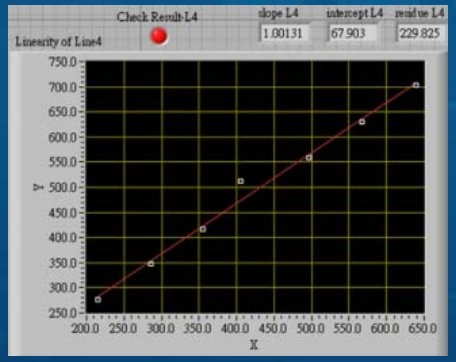


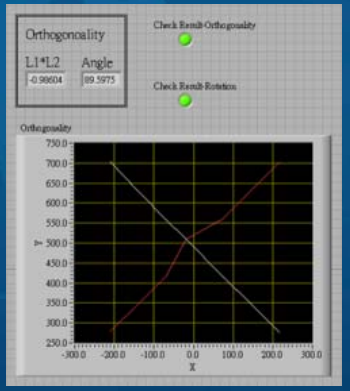


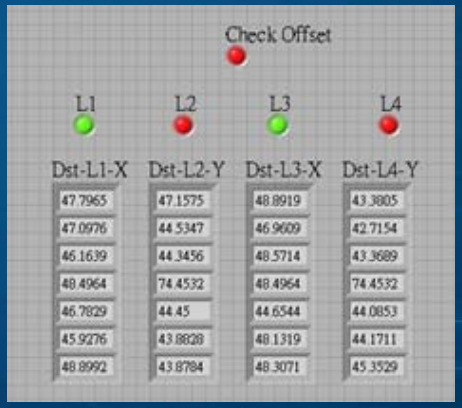


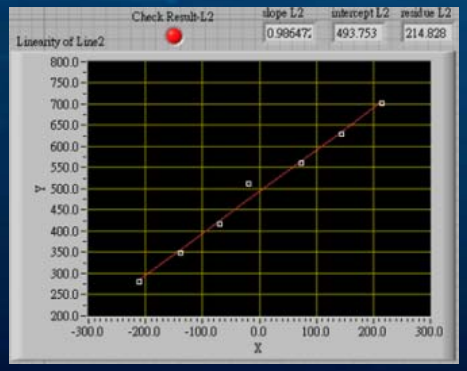
- One point fail.

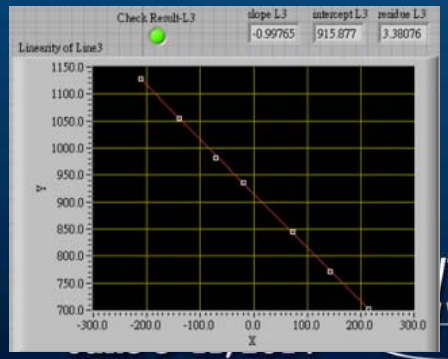


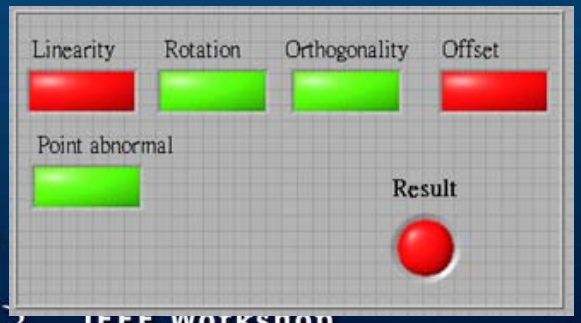




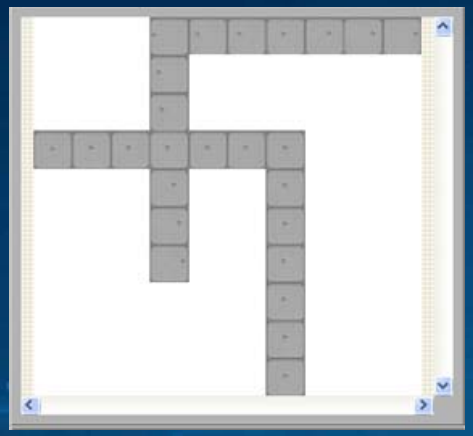


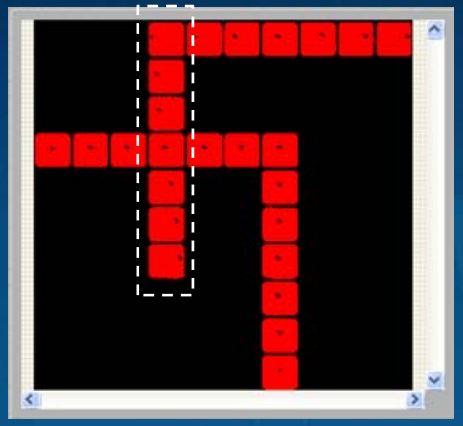


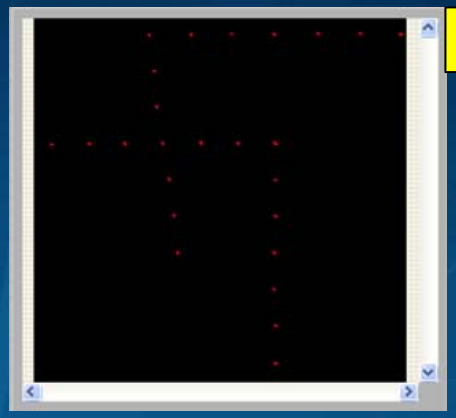




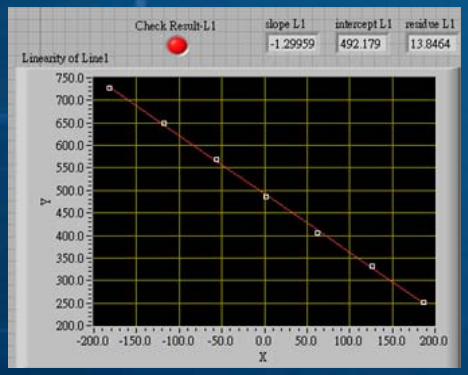
Result-case#3

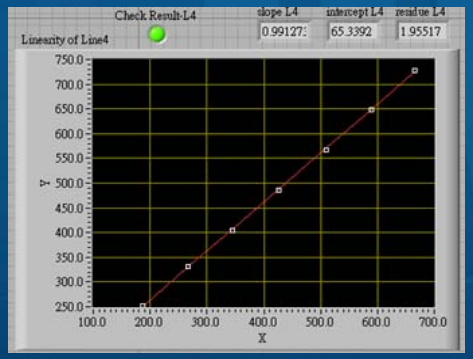


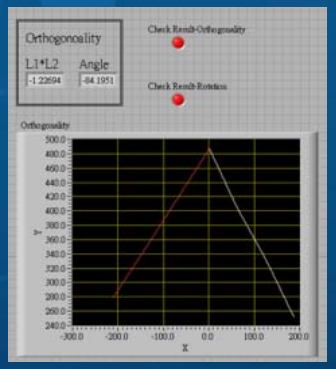


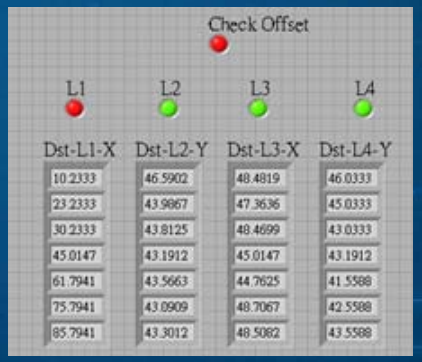


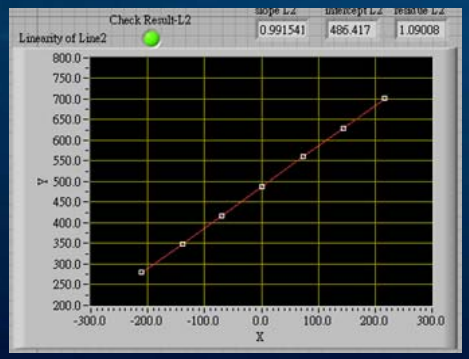
- Y-axial fail.

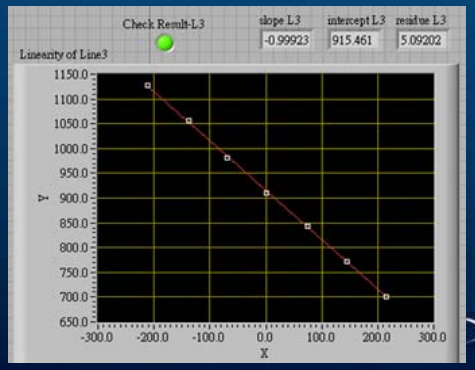


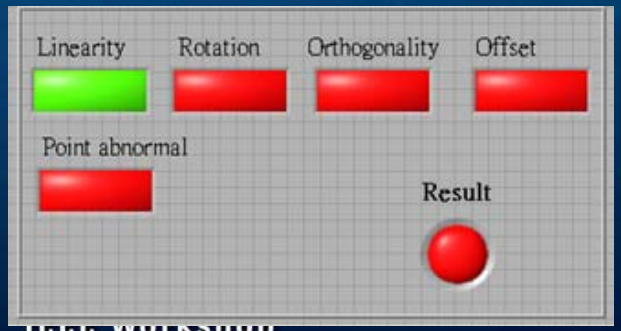






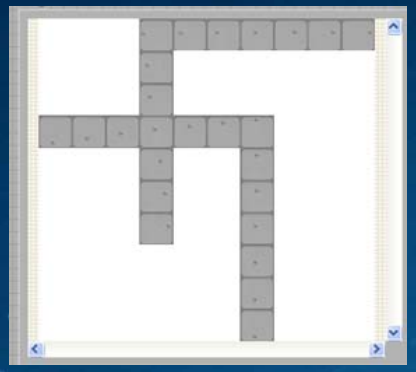


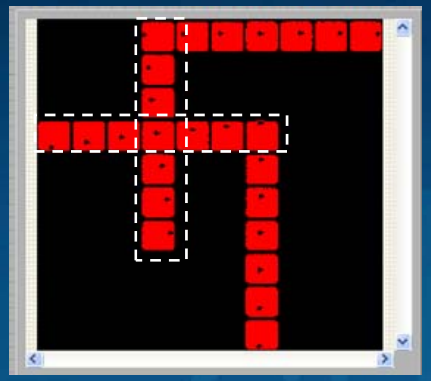


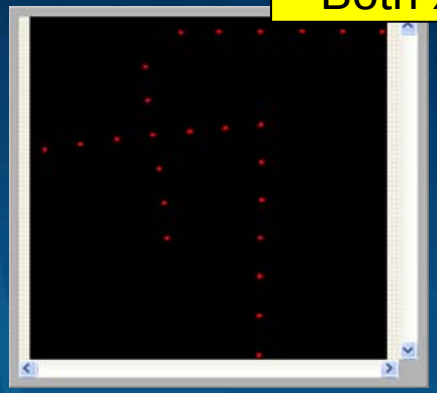


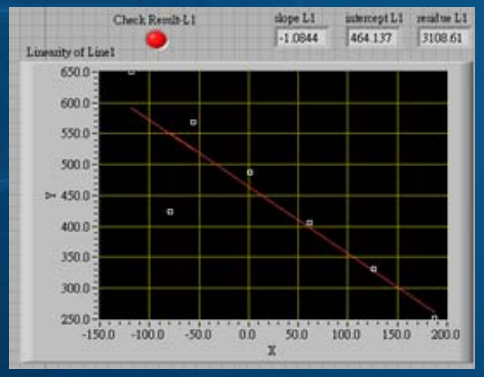
Result-case#4

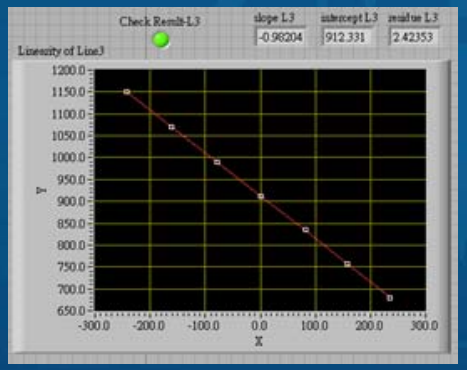
- Both X&Y axial fail.

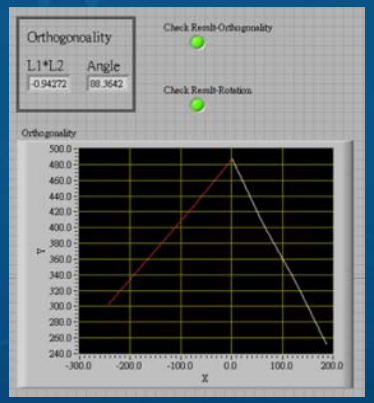


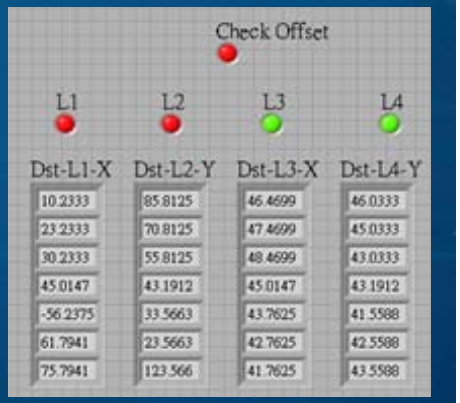


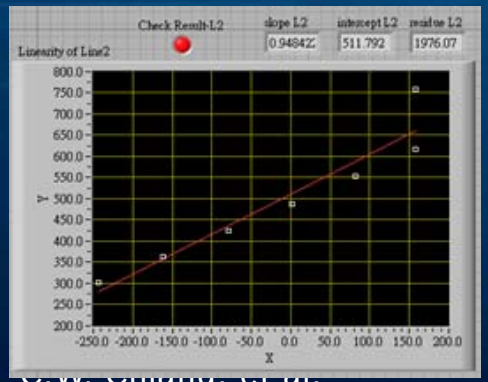


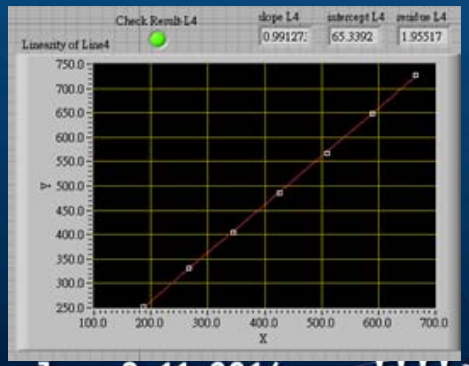


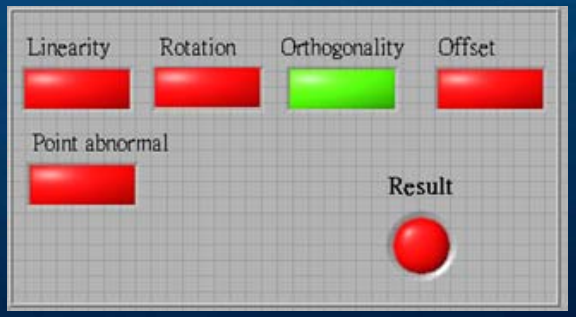






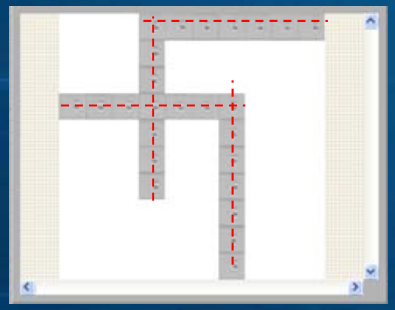
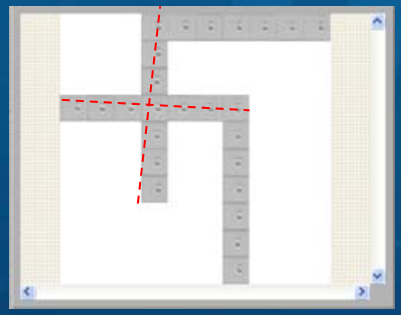
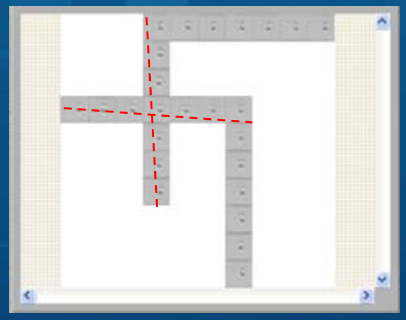
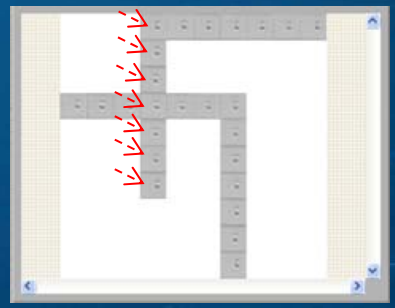




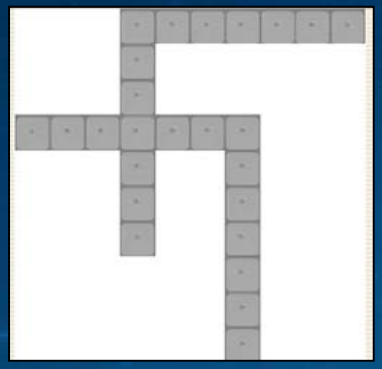
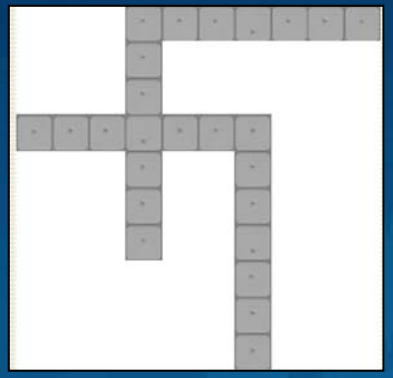
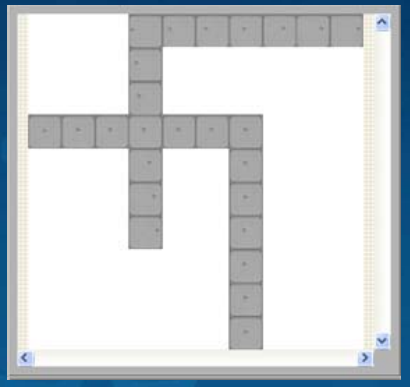
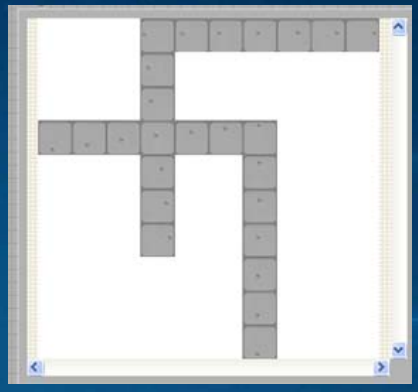
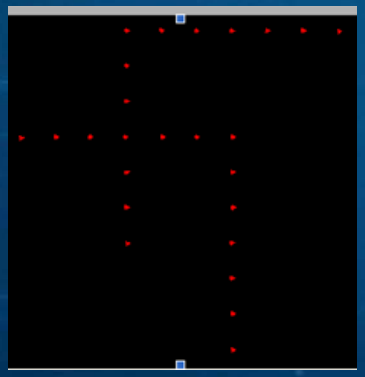
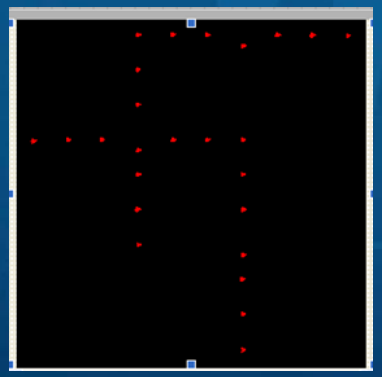
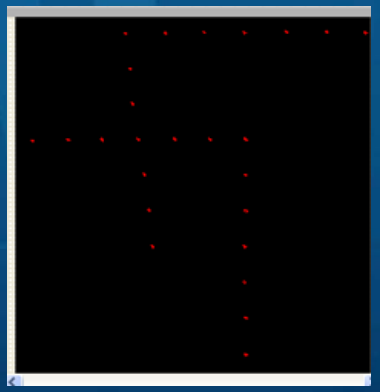
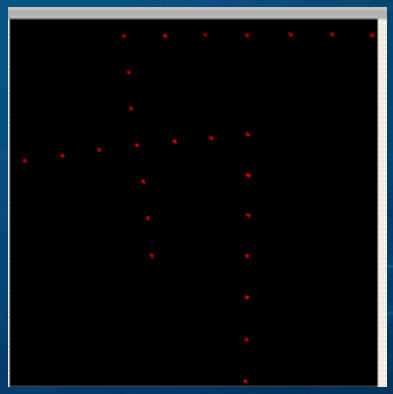
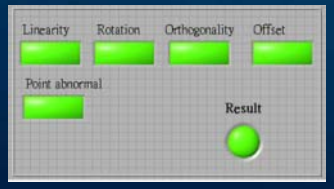
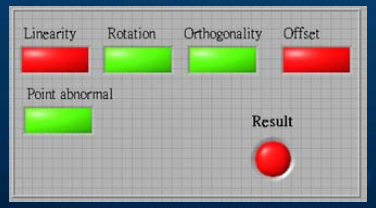
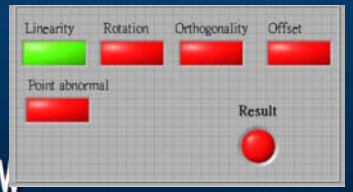
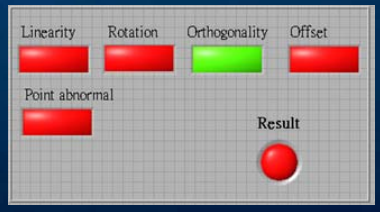


Discussion of Results

- **To our experience, Orthogonality and linear failures are mostly from prober itself, offset failure is from operation, and rotation failure is from prober and wafer, probe card or operation.**

Linearity check	Rotationality check	Orthogonality check	Offset check
			
• Calculate 4 linear equation.	• Calculate the angle	• Calculate the status of orthogonalithy.	• Calculate the offset of each pad.

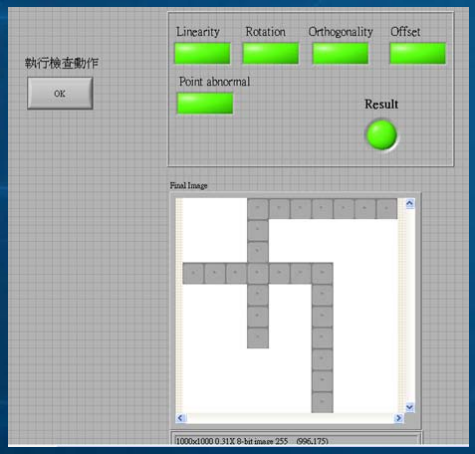
Summary

Pass	1-point NG	1-axial NG	2-axial NG
			
			
			

Conclusion

- Through above method, we can quickly decide the misalignment root cause, such that we can fix it on the right way that save both time and money.

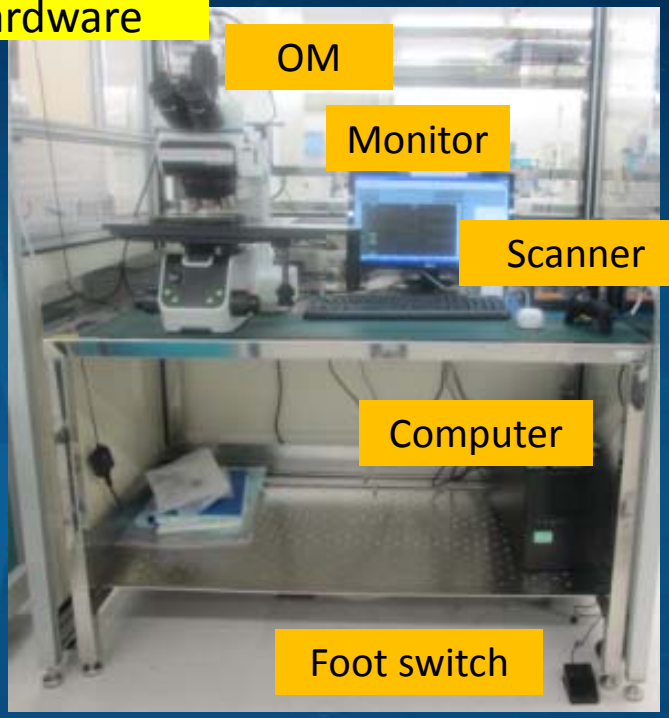
- UI

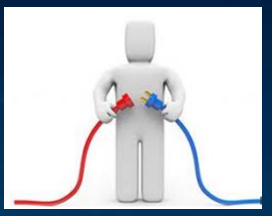


- After implementing the method to periodically check prober indexing, we get three major advantages,
  - Efficiency : The recursion chart is created automatically without handiwork.
  - Accuracy : The result is checked by software without any subjective opinion.
  - Reliability/Repeatability: The result is the same whatever who executes the program.

Follow-On Work

Hardware





- **Regarding step1 (On-line Image take/load), we would like to make it easy while taking picture. We will implement a footswitch to replace keyboard to improve the procedure.**
- **Meanwhile, we are thinking a method which can make sure PM situation while probing, and don't suffer lots of testing time.**

Many Thanks