Probing Process Analysis and Continuous Improvement

John Strom
Applied Precision Inc.
(425) 557-1000
jstrom@api.com

- **Analyze the current probing process**
- **Present technique for measuring process variations**
- **Show examples of real customer data**
- **Identify key process parameters (Report Card)**

Process Complexity is Increasing

- Multi-Dut testing
- Larger card probe arrays
- High pin count probe cards
- High probing loads
- Test at temperature
- New probe card technologies
- Smaller pads and tighter pitches
- Pad damage concerns

"Understanding of variation, including appreciation of a stable system, and understanding of special causes and common causes of variation, are essential for management of a system"

Edwards Deming: ***The Deming System of Profound Knowledge***

Current Process

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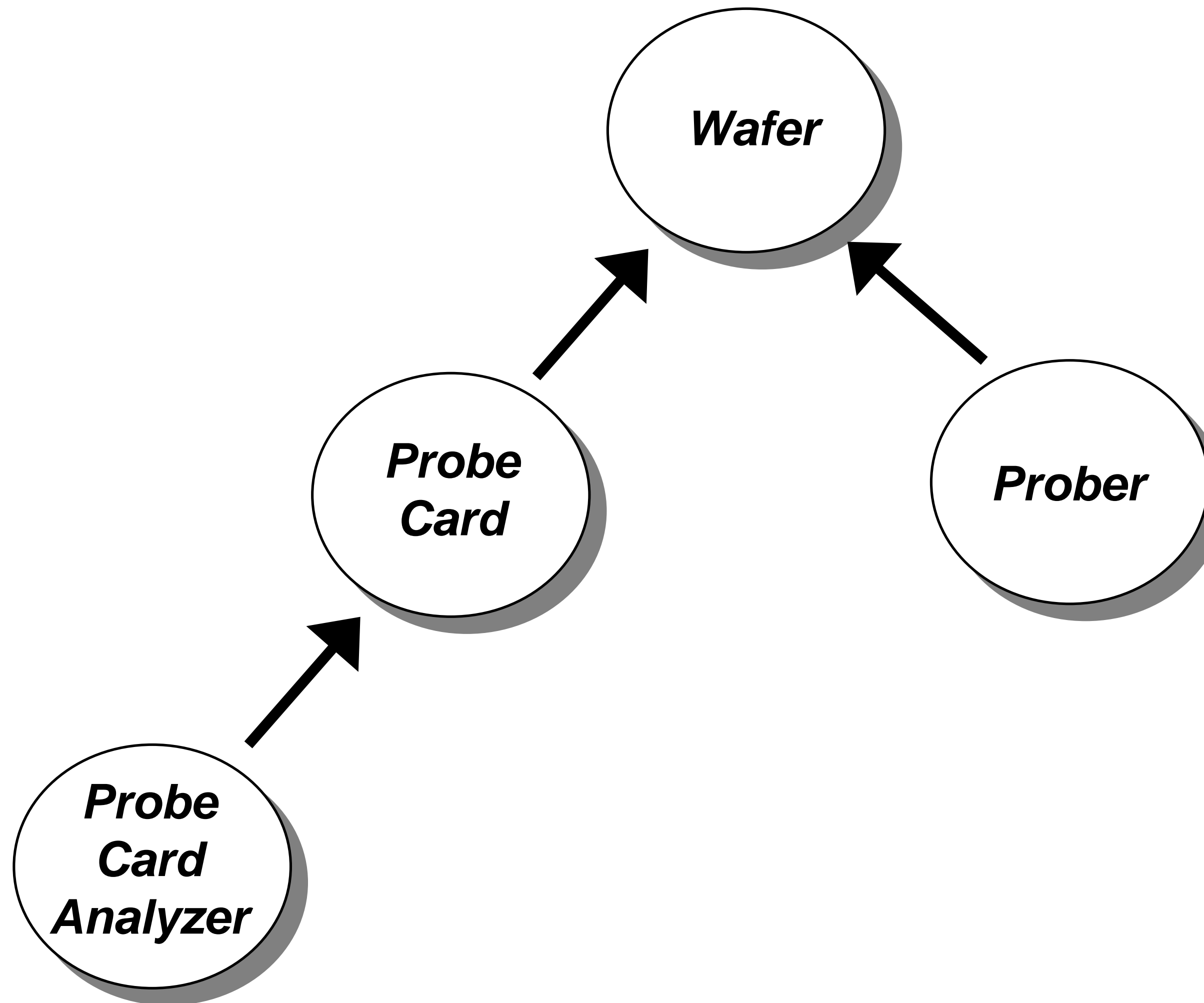

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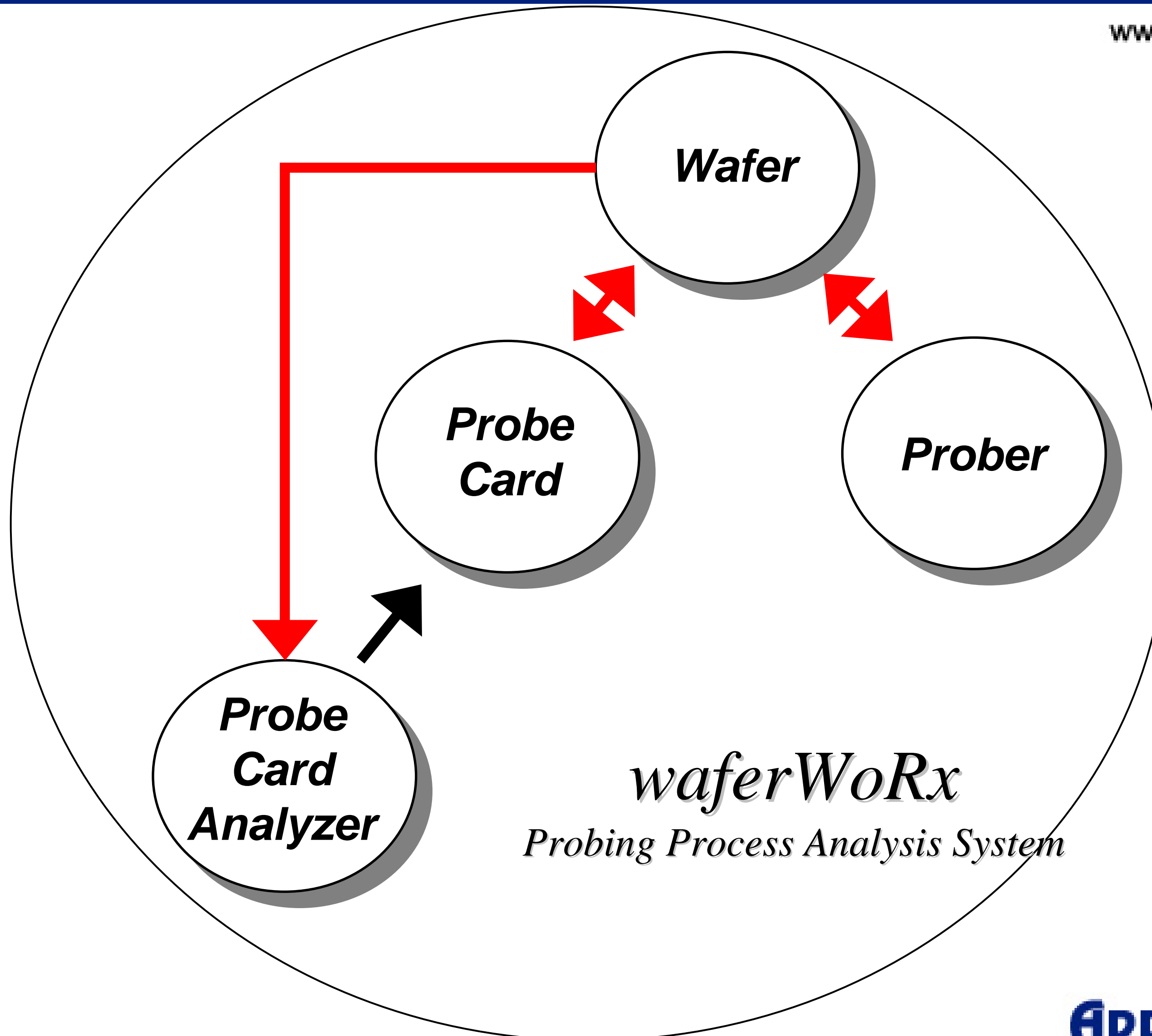
Closed Loop Process



Single Wafer Probing Analysis Steps

Step 1: Measure Scrub properties

- Measure Scrub Relative to Pad Position

Step 2: Die Pattern Analysis

- Die Model Fit: Touchdown Variation

Step 3: Wafer Pattern Analysis

- Wafer Model Fit: Prober / Probe Card Analysis

Measure Scrub Properties

Step 1: Measure Scrub Relative to Pad Position

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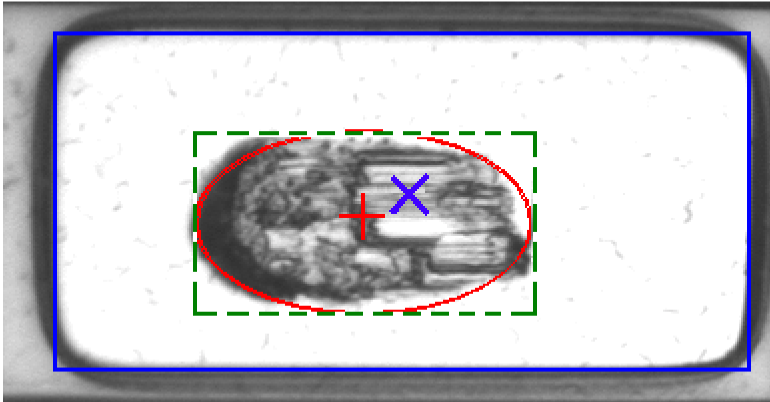

- Center of the passivation opening (blue ×)
- Center of the scrub mark (red +)
- Scrub Mark Area / Size (red ellipse)
- Bounding Box of the scrub mark (green dashed box)
- Passivation opening size (blue box)

- Position of scrub mark
- Size of scrub mark
- Angle of scrub mark
- Size of passivation opening
- Pad damaged
- Scrub mark distance from the edge of the pad.
- … Over 40 total parameters

Die / DUT Pattern Analysis

Step 2: Die Model Fit

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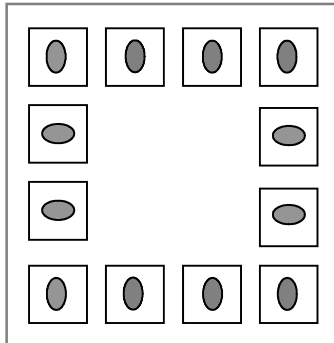
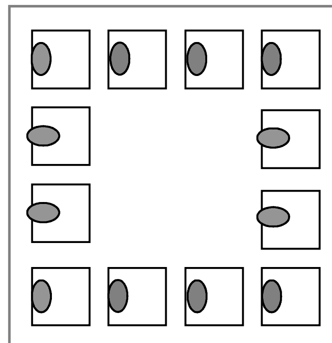
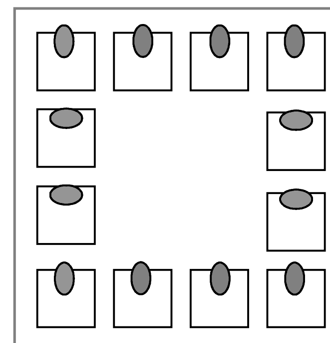
No Error



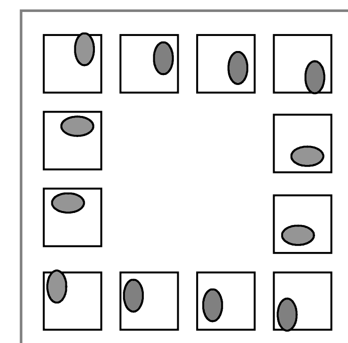
X Error



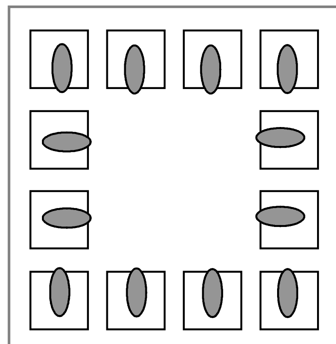
Y Error



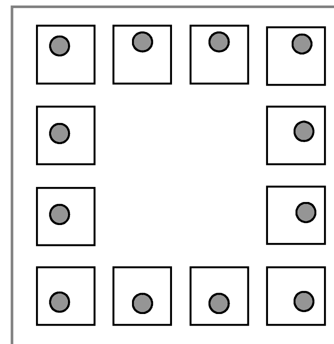
Yaw Error (theta)



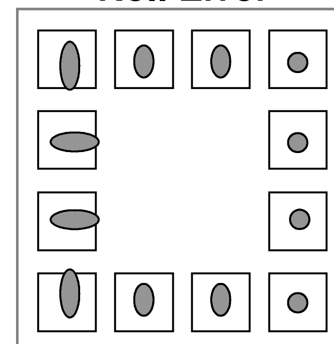
Large Overtravel & Card Array Scaling



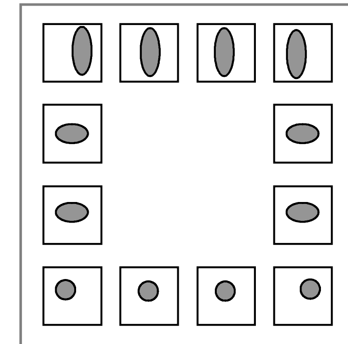
Small Overtravel & Card Array Scaling



Parallelism & Stage Deflection Roll Error



Parallelism & Stage Deflection Pitch Error



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Wafer Pattern Analysis

Step 3: Wafer Model Fit

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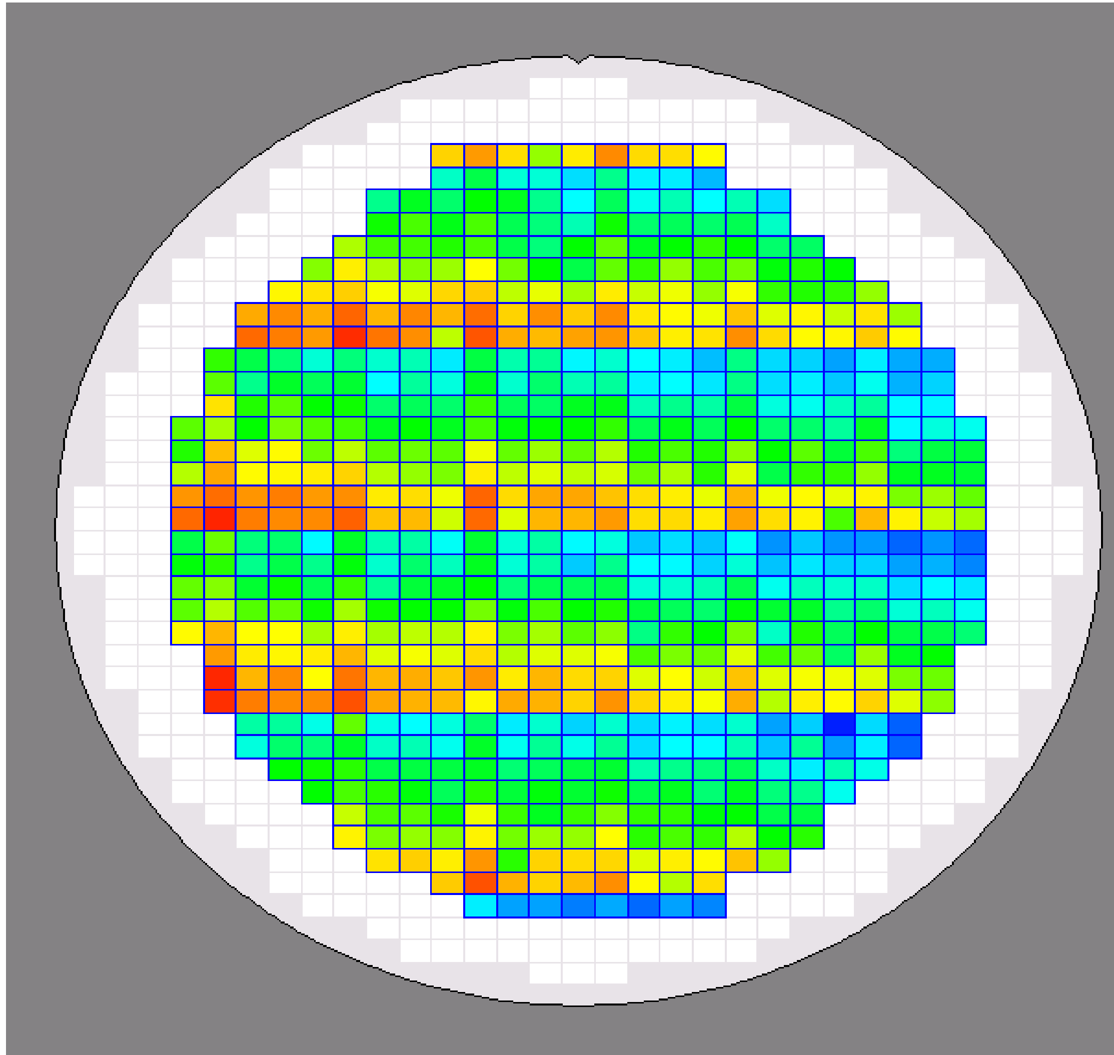

Wafer Model Fit

1) Setup: X,Y Offset
2) Setup : Card Parallelism
3) Setup : Card Theta
4) Setup: Wafer to Stage Theta
5) Stage: Overtravel Variation
6) Stage: X,Y Stage Stepping
7) Stage Deflection
8) Probe Card Accuracy
9) Probe Card Repeatability

1. Setup X,Y Offset
2. Setup Wafer to Stage
3. Stage Stepping Accuracy
4. Deflection & Card Parallelism
5. Multi-Dut Probe Card Performance at Temperature

Setup - X,Y Offset

Example # 1

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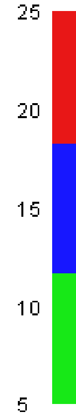
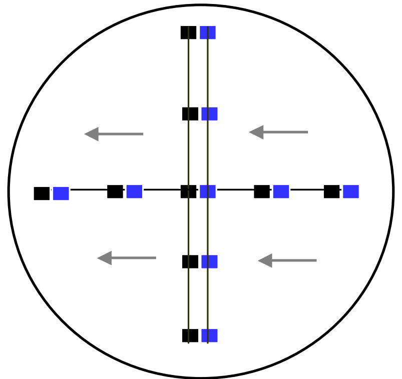
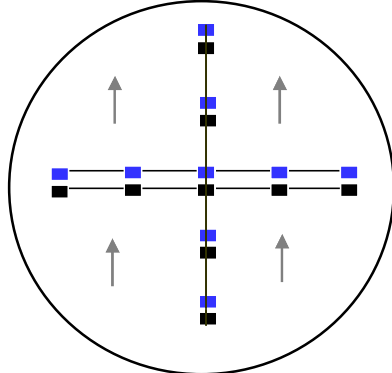


Pass 0
Fail 0
Near 0
Max 21.74
Min 9.24
Ave 14.72
Rng 12.50
Stdev 2.72





X,Y Setup Error

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Setup - X,Y Offset

Example # 1

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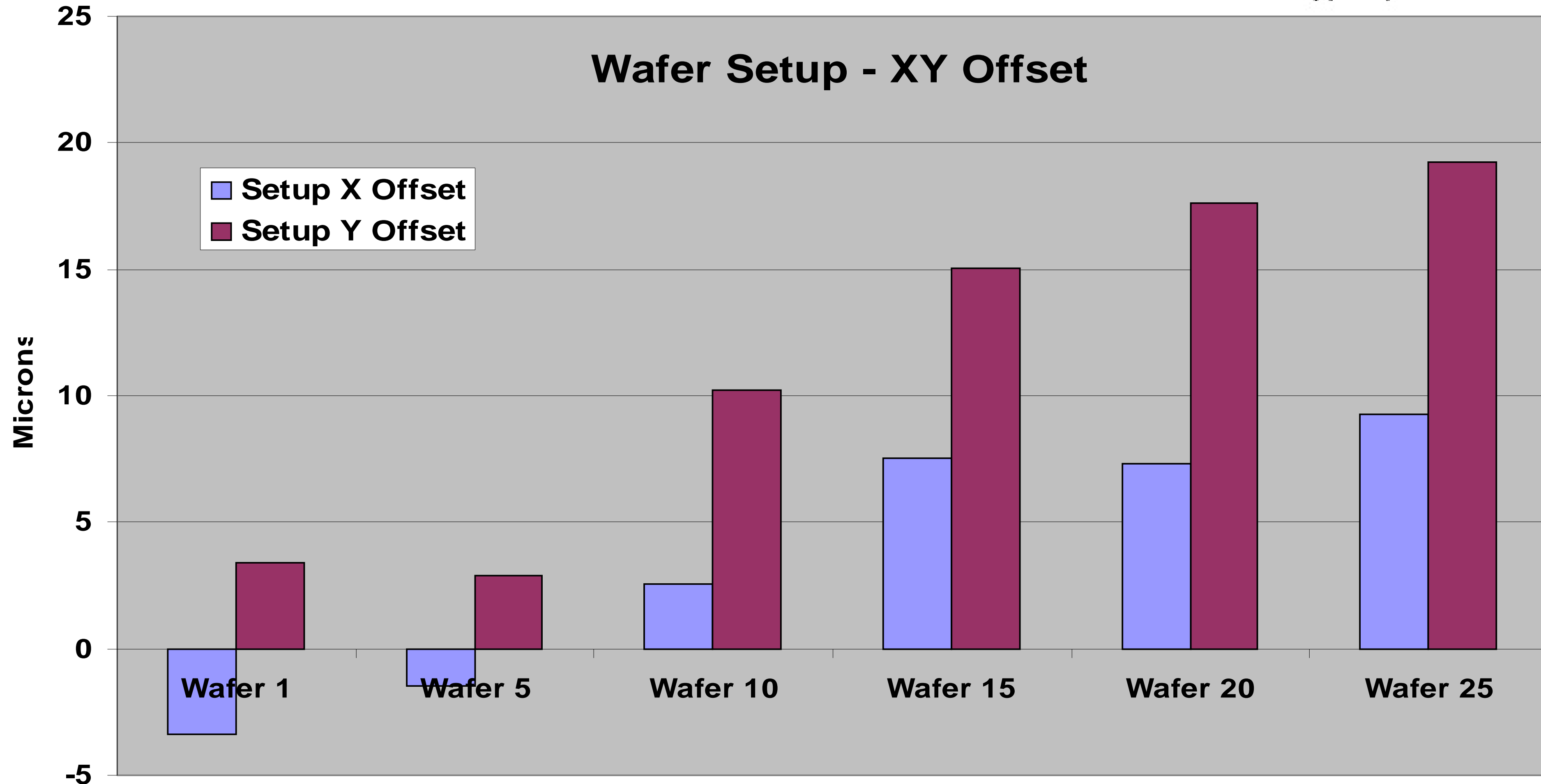

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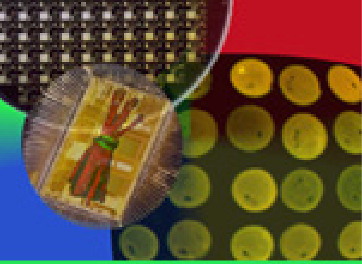
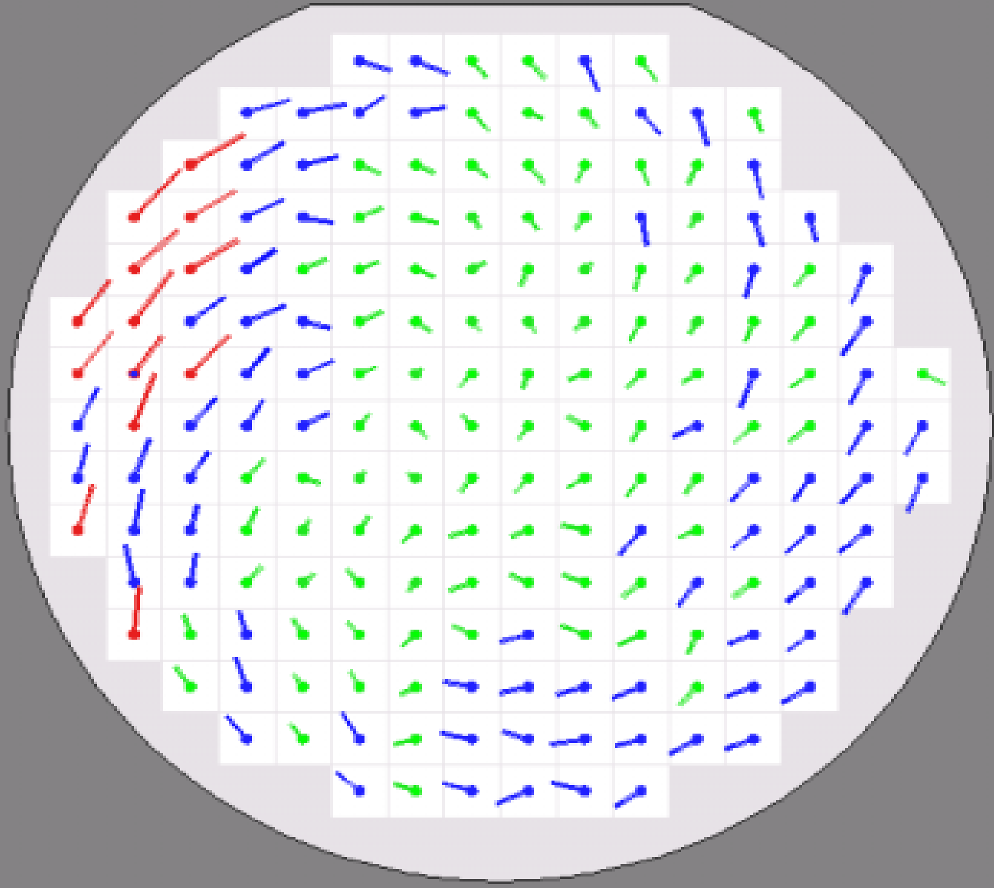
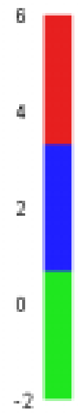


Setup Wafer to Stage

Example # 2





Pass 0
Fail 0
Near 0
Max 4.66
Min 0.10
Ave 1.65
Rng 4.56
Stdev 0.88

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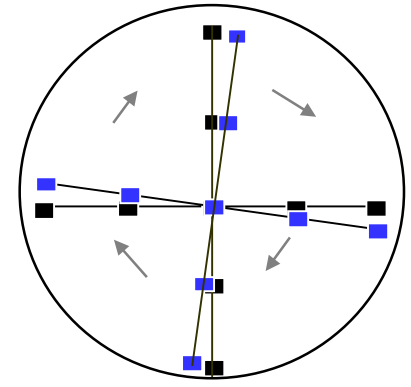
Wafer Alignment



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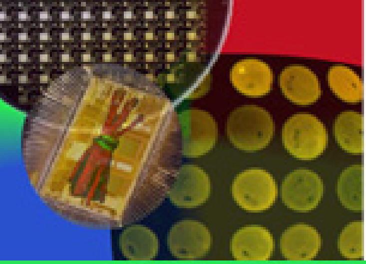

Stage Stepping Accuracy

Example # 3

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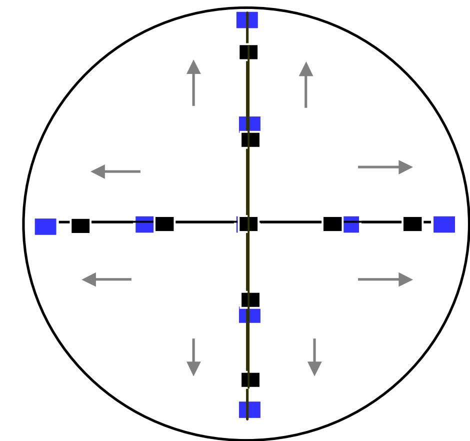
10
5
0

Pass 0
Fail 0
Near 0
Max 9.99
Min 0.18
Ave 2.97
Rng 9.81
Stdev 1.63

Scaling & Stepping Errors



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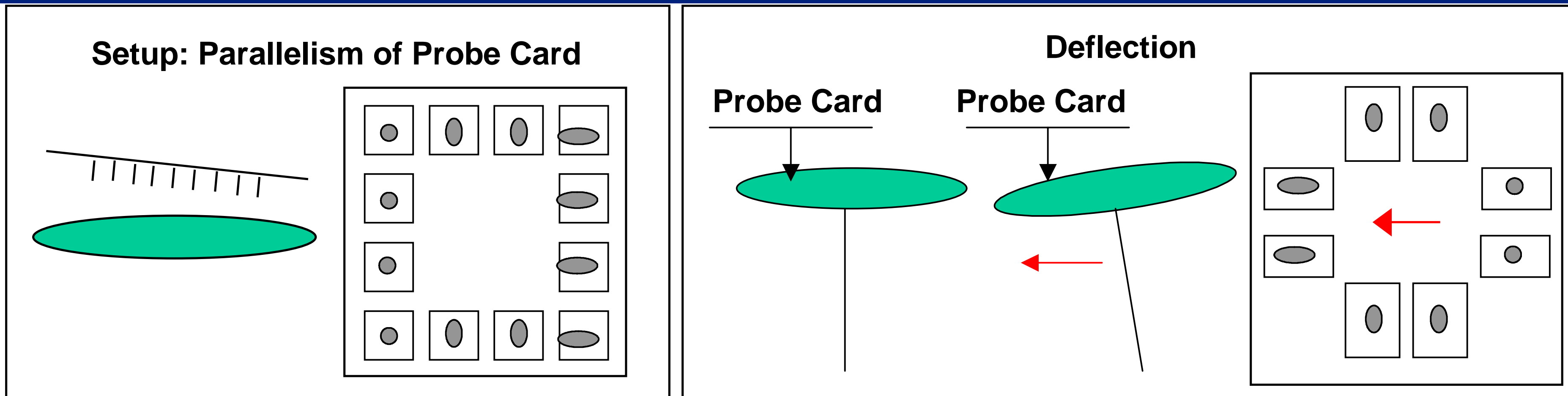
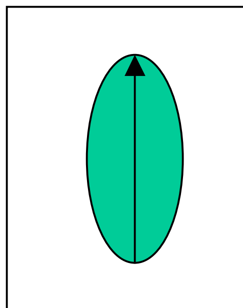
Deflection & Card Parallelism

Example # 4

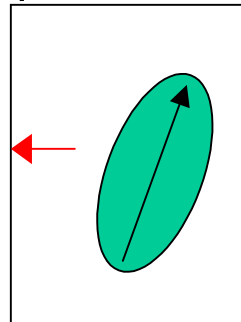


Deflection: Probe Card / Probe Dependent

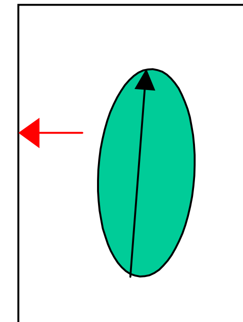
Normal Scrub



Stage Translation
Expected Scrub



Actual Scrub



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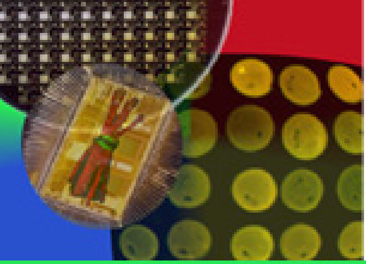
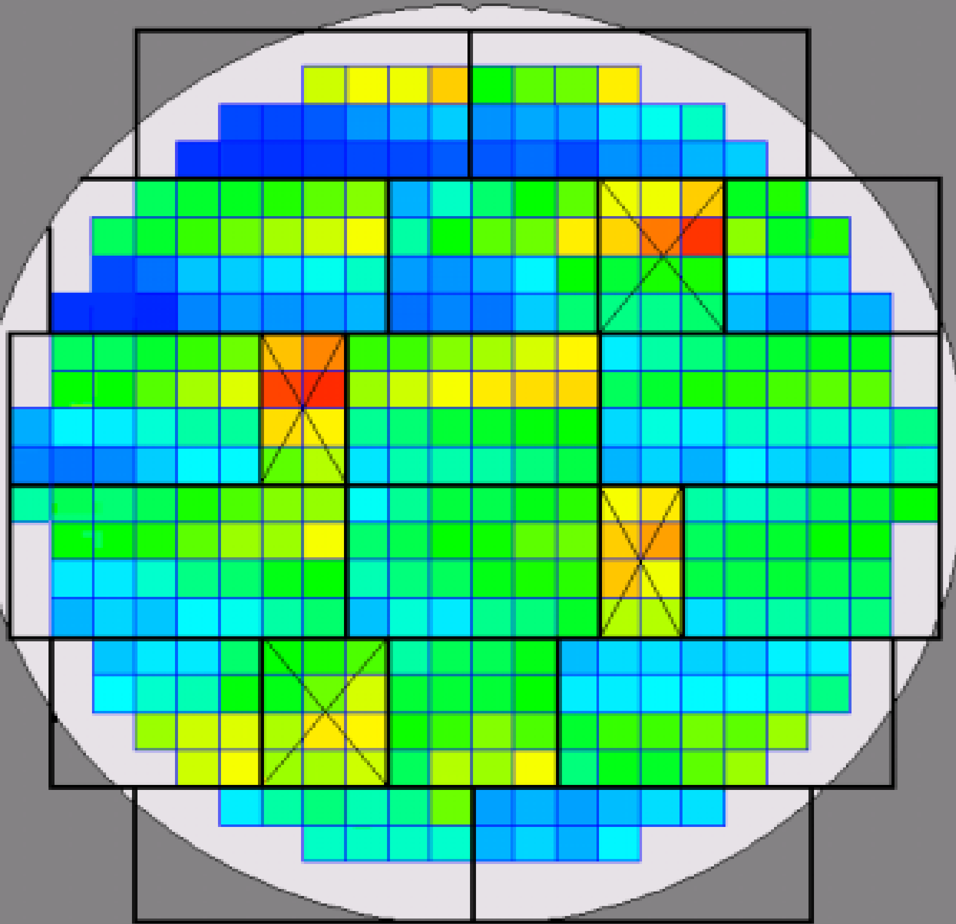
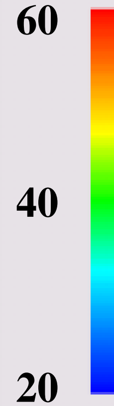


Deflection & Card Parallelism

Example # 4





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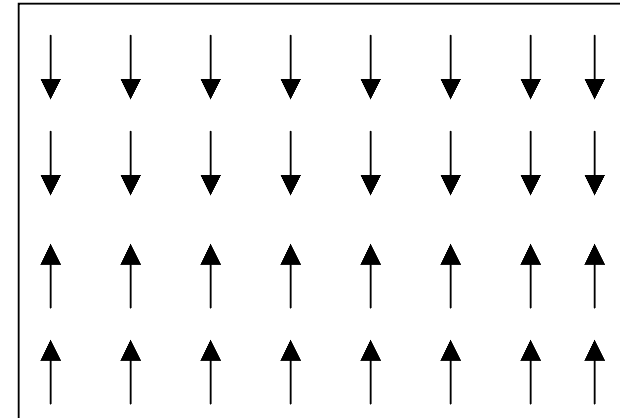
Probe Card



- 32 DUT (4x8)
- Cantilever

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Deflection & Card Parallelism

Example # 4

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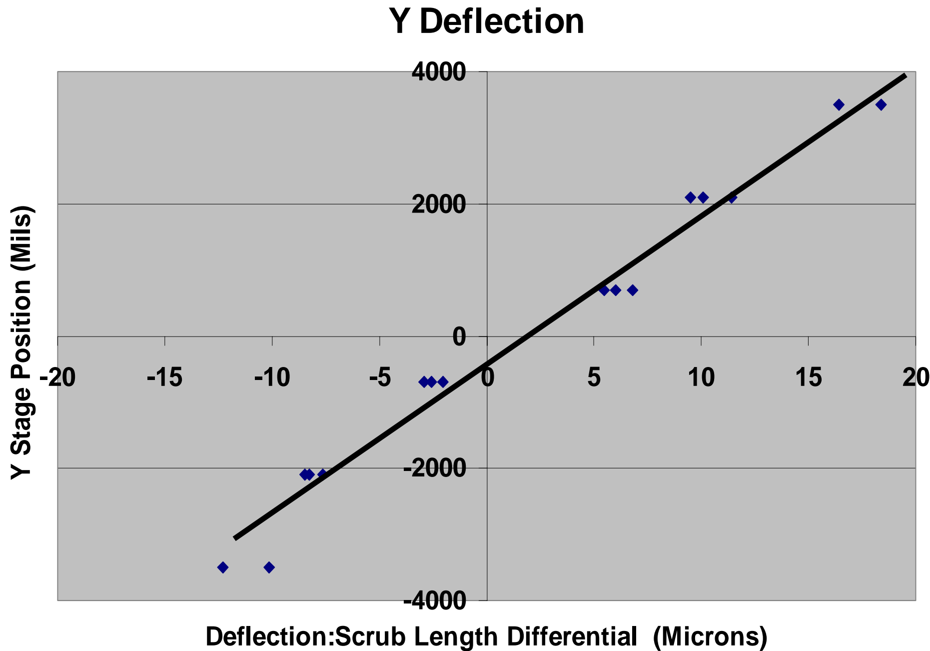

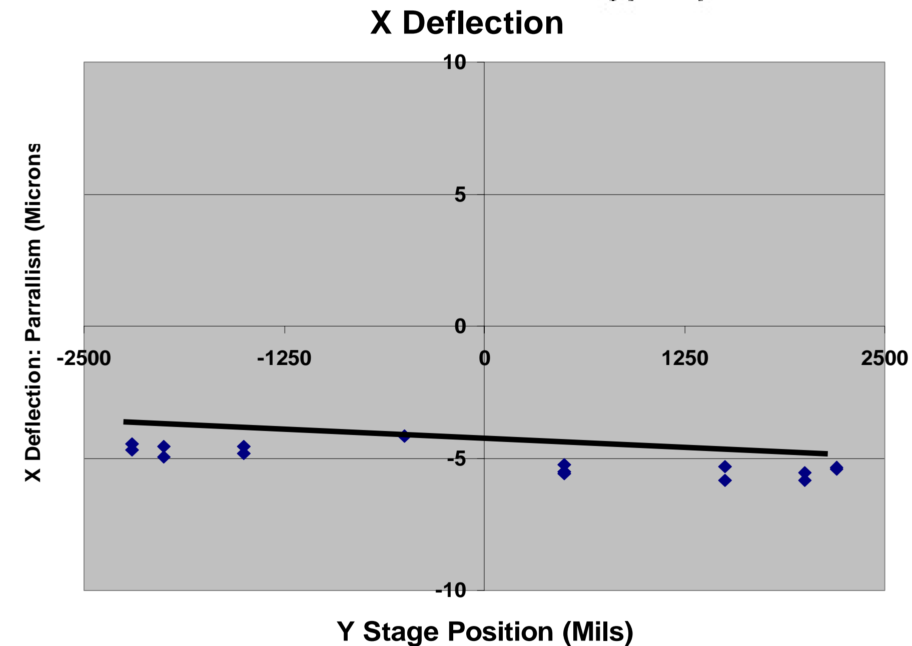

	Microns
Card Pitch	5.1
Card Roll	3.8
Max Y Deflection	15.2
Max X Deflection	1.3

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Multi-Dut at Temperature

Example # 5

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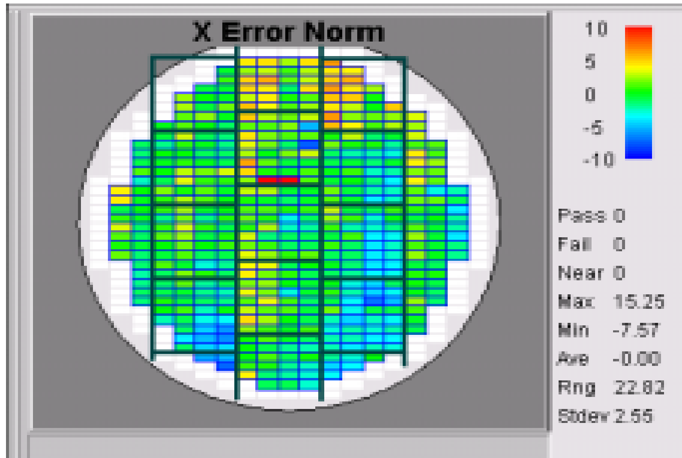
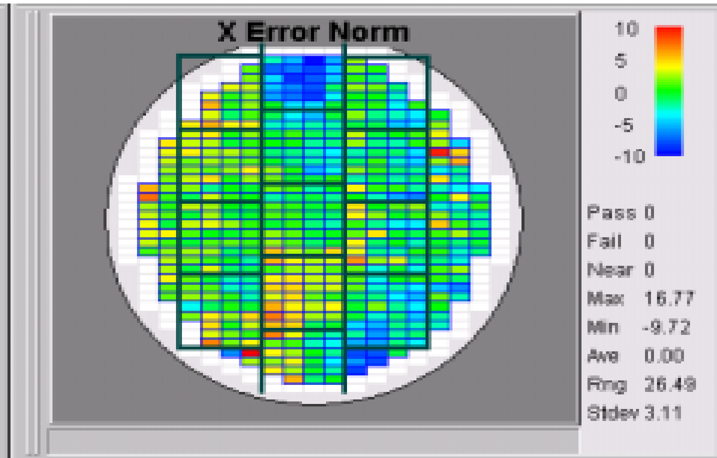
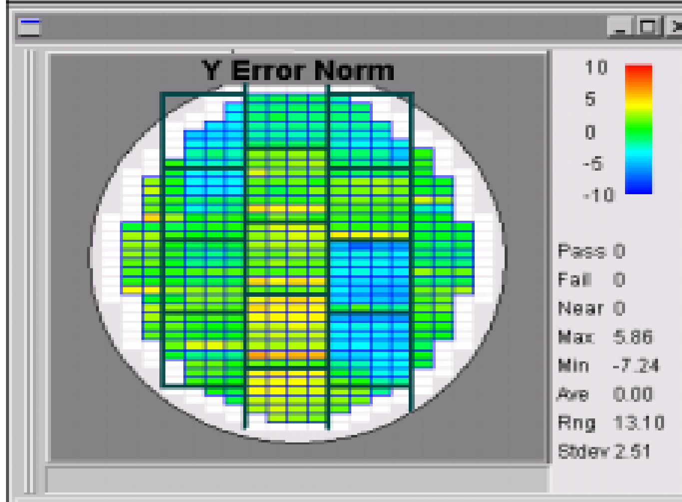
Ambient | 135 C

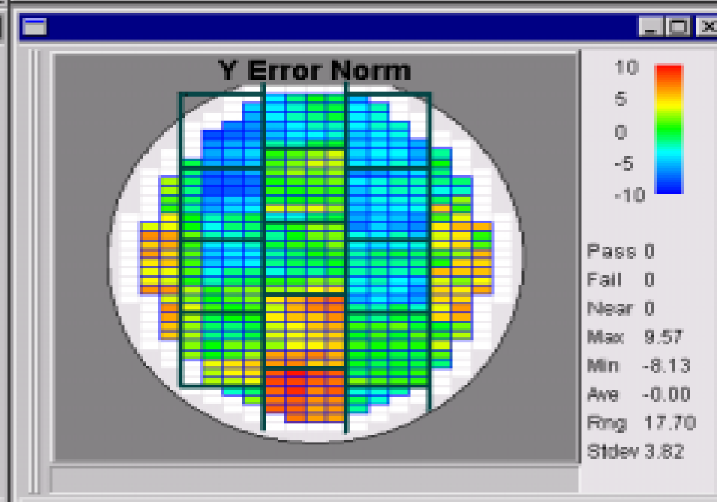
X





Y





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Multi-Dut at Temperature

Example # 5 - Probe Position Differential

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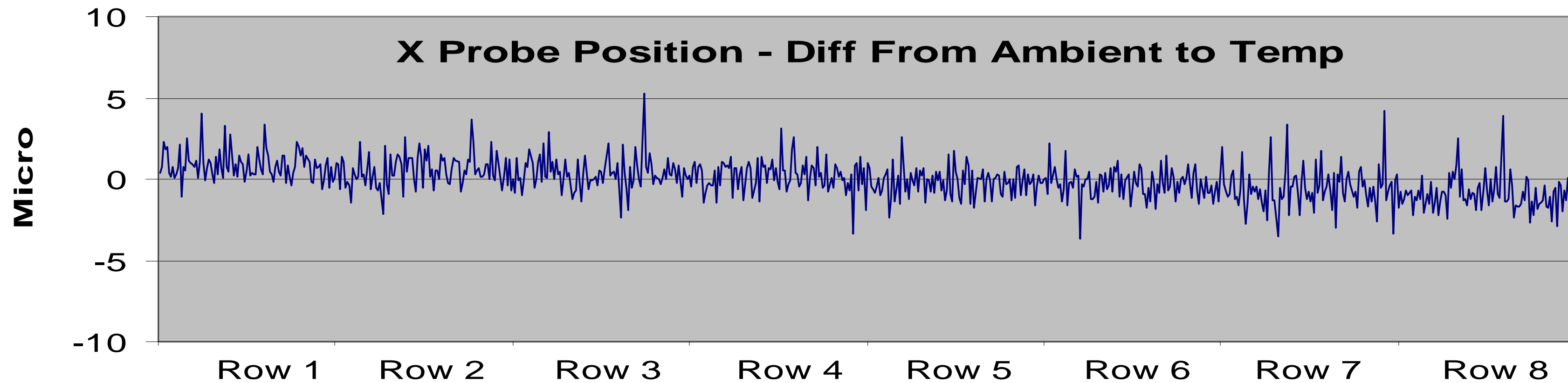

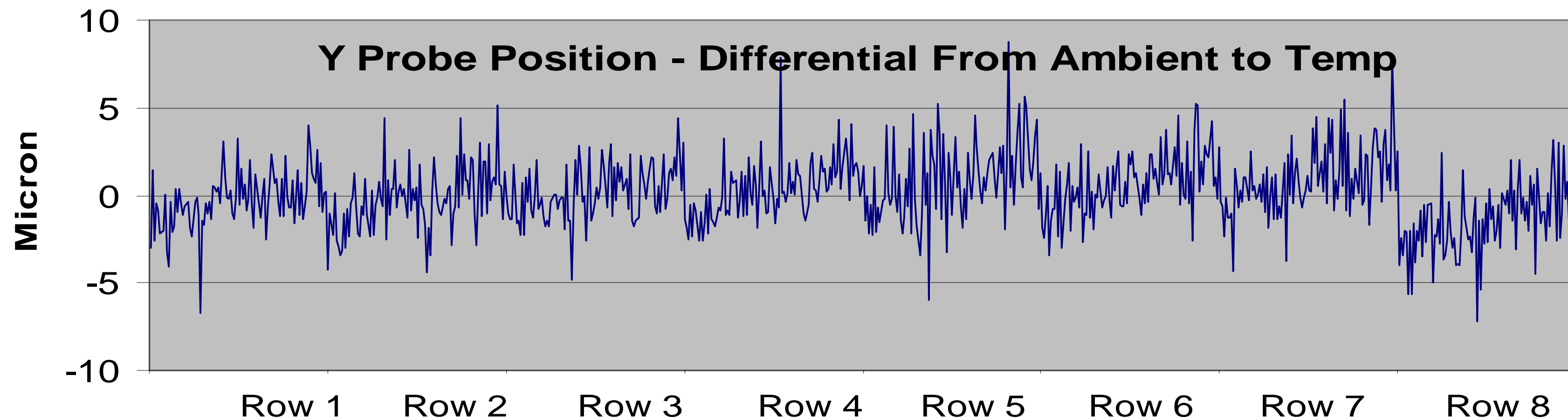

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Multi-DUT at Temperature

Example # 5 - Probe Card Performance

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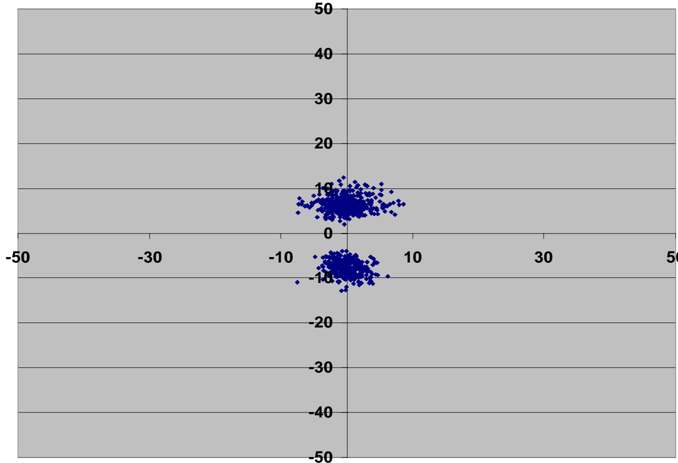
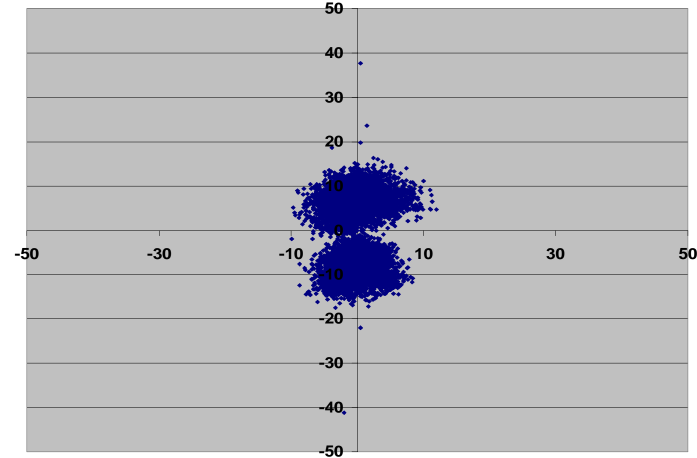
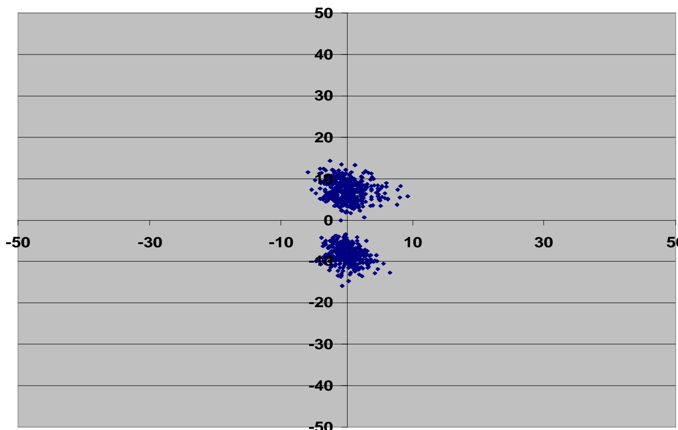
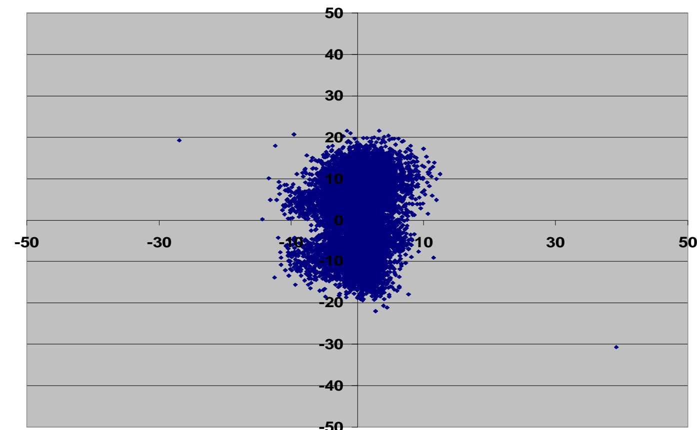
	Probe Card	Scrub Marks
Ambient		
135^0 C		

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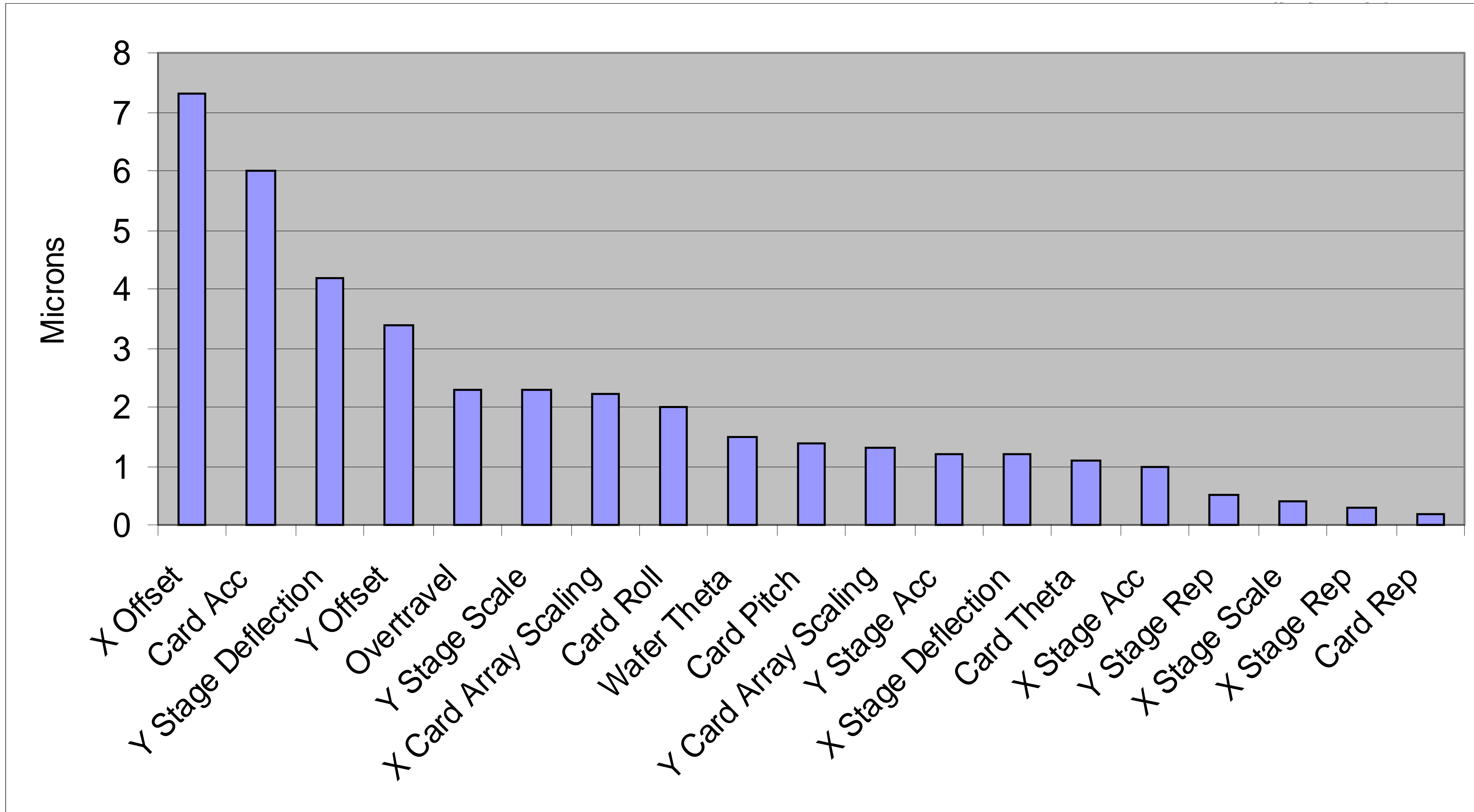
Process Report Card



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Calculate Process Capability (Cpk)

- Calculate a overall process Capability #
  - Cpk = Spec Width / Process Spread
  - Cpk = Pad Size / (v1+v2+v3+v4…)
- Process Improvement Evaluation
  - What if X,Y Setup variation is improved?
  - What if the probe card is more accurate?
  - What if the Pad size is changed?
  - What if the prober has a stiffer stage?
  - What if...

Conclusions

- View the probing process as one system
- Measure the variations in the process
- Focus on the key parameters that influence the process
- Continually evaluate improvements or changes to the process

Acknowledgements

- Tony Angelo
  - Probe Hardware Development Eng.
  - Motorola FMTC
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- Debbie Miller
  - Engineering Technician
  - Micron
- Bob Heiligenberg
  - Semiconductor Product Line Manager
  - Applied Precision Inc.
- Ryan Hardie
  - waferWoRx Project Manager
  - Applied Precision Inc.
- Ron Metzger
  - Test Engineer
  - Applied Precision Inc.