

# ***Performance of a Next Generation High Speed, High Precision, Probe Card Analyzer***

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# ***Presentation Agenda***

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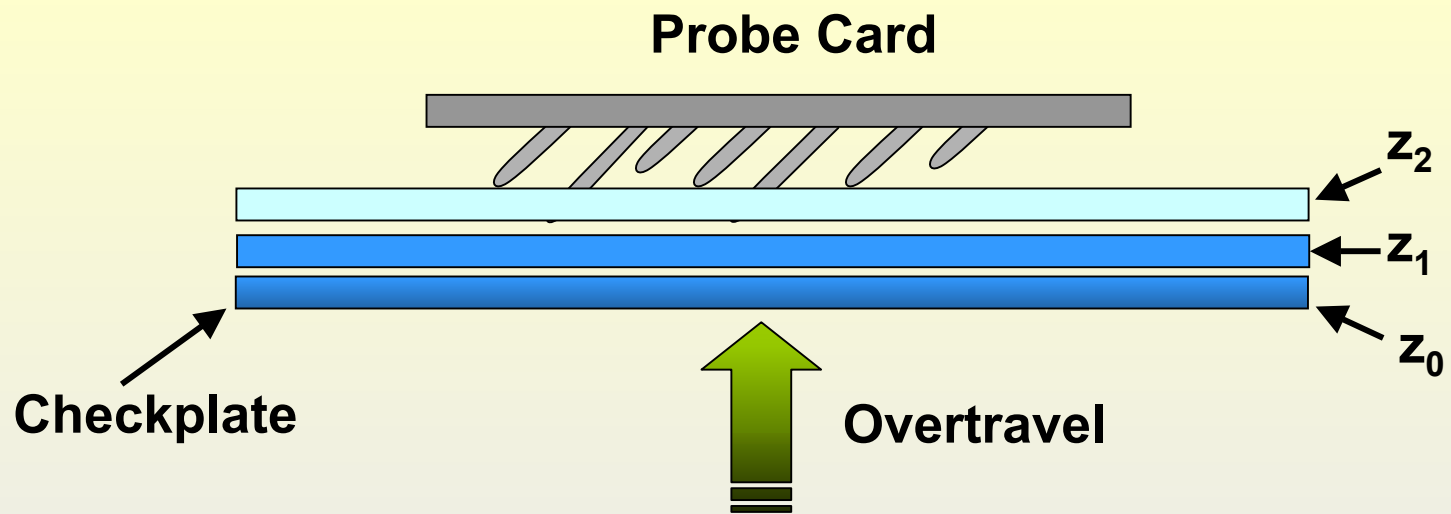
- ***Motivation for next generation PCA***
- ***Problems with conventional PCAs***
- ***probeWoRx – next generation PCA***
- ***probeWoRx Benefits***
- ***probeWoRx Results***

# Motivation

- Ever increasing need to test more devices simultaneously
- Probe card pin counts and loads increasing
  - Advanced Technology Cards with > 10,000 probes
- Test Time
  - Need to keep test times acceptable
  - Minutes, not hours
- Accuracy
  - Increased loads cause structural deflection and degrade accuracy
  - Tighter probe pitch and smaller pads require higher accuracy

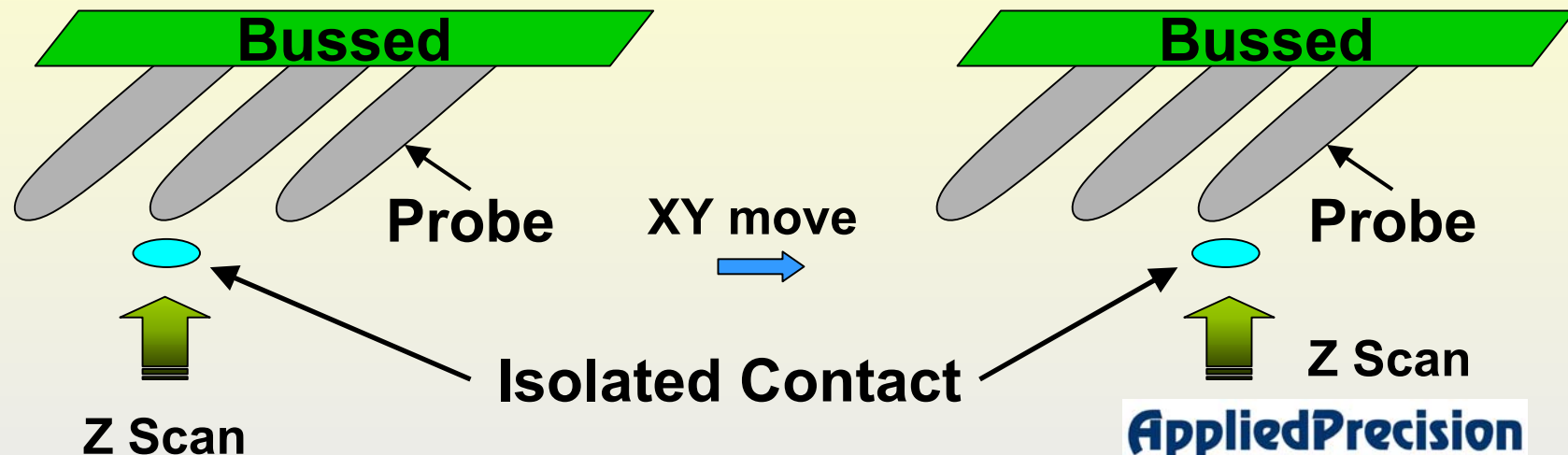
# Conventional Probe Card Analyzers

- Electrical Planarity: Non-Bussed Probes
  - FAST
  - Scan checkplate in Z
  - Continuity measurement at each Z step
  - Accuracy based on stage position



# Conventional Probe Card Analyzers

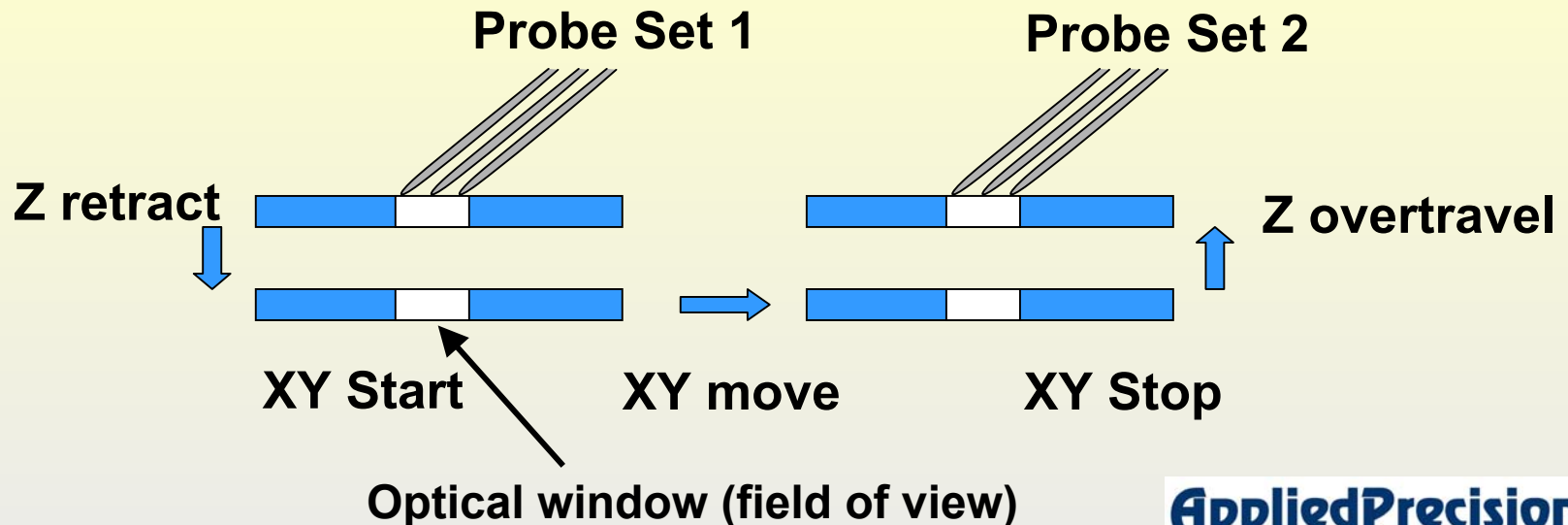
- **Electrical Planarity: Bussed Probes**
  - SLOW!!
  - Isolated contact driven individually to each probe
  - Scan contact in Z
  - Continuity measurement at each Z step
  - Accuracy based on stage position
  - Isolated contact will wear and accumulate dirt/debris



# Conventional Probe Card Analyzers

- Optical Alignment

- SLOW!!
- Each probe set driven individually to optical window
- Measure XY position at zero and nominal overtravel
- Accuracy based on stage position
- Optical window will wear and accumulate dirt/debris



# *Conventional Probe Card Analyzers*

- Drawbacks to Conventional Planarity and Alignment Measurements
  - SLOW!!
  - Measurement results directly related to stage accuracy and repeatability
  - Measurement results degraded by dirt/debris accumulation at isolated contact/window
  - Measurement accuracy is also sensitive to
    - Abbe Error
    - Deflection under load
    - Temperature changes

# probeWoRx

## Next Generation Probe Card Analyzer (beta system)





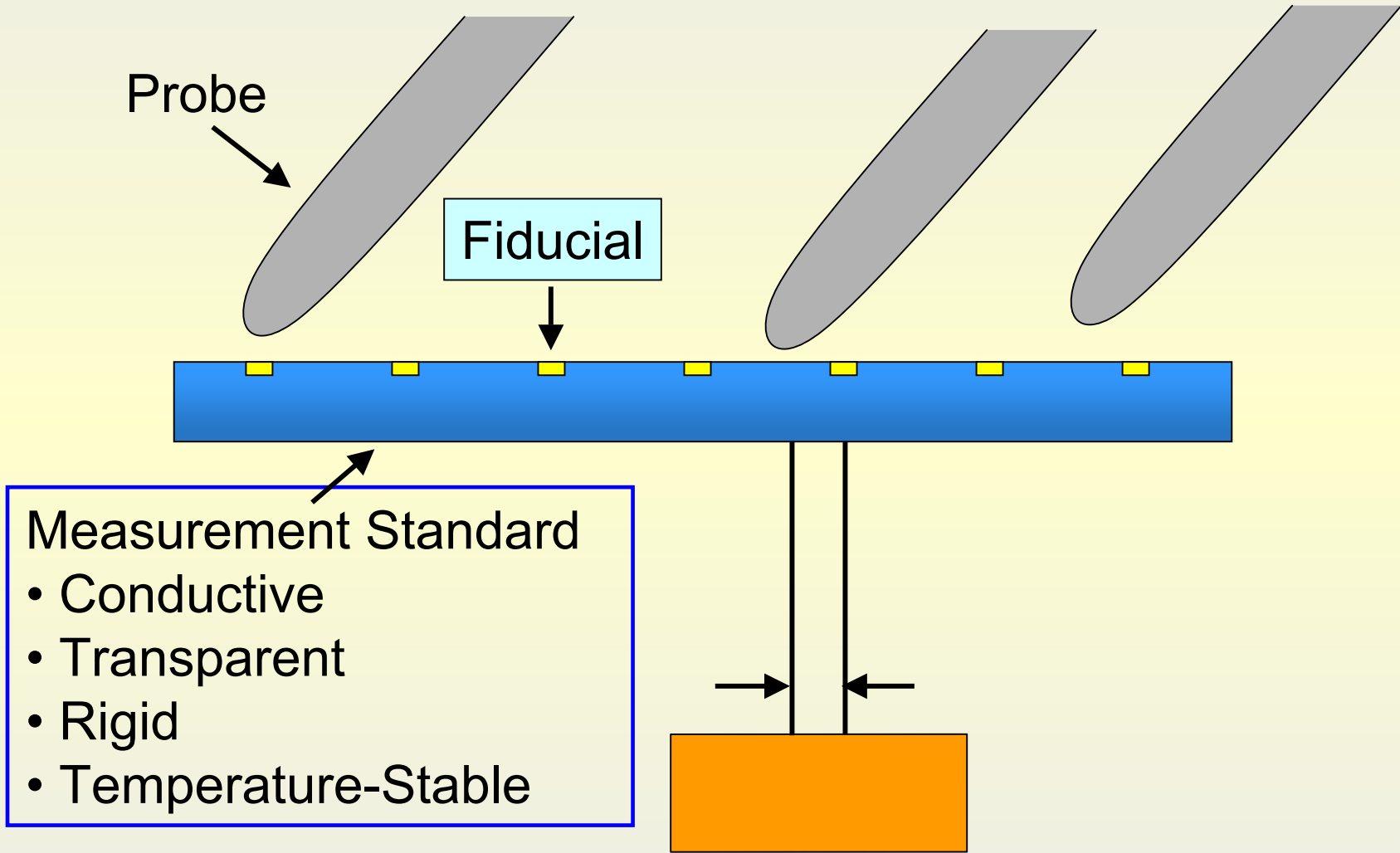
# *probeWoRx Capabilities*

- *NEW Optical Planarity and Alignment*
- Electrical Planarity
- Leakage
- Contact Resistance
- Capacitance
- Electrical Components (capacitors, resistors)
- Wirechecker
- Probe Force
- Cleaning
- Rework

# *probeWoRx New Metrology Technique*

- **3D Optical Comparative Metrology (3D-OCM)**
  - Compute **both** planarity and alignment from optical measurements
  - Measure probe locations relative to NIST traceable measurement standard
    - Extremely flat measurement standard ( $< \frac{1}{4}$  wave)
    - Extremely accurate photolithographically-defined fiducial grid ( $< 0.5\mu\text{m}$ )
  - Measurement standard and probes are co-located
  - Multiple patents pending

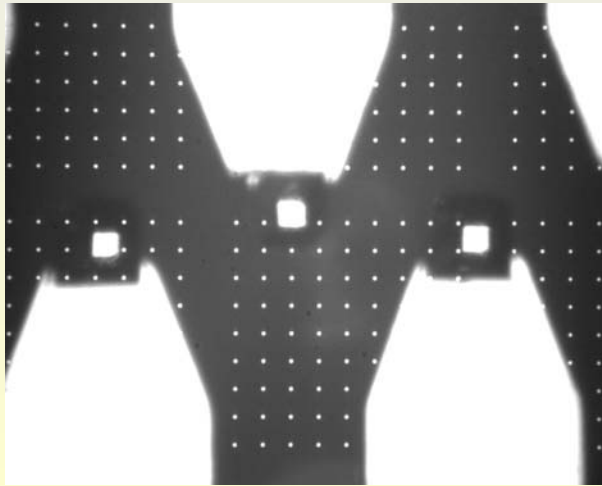
# 3D-OCM: Measurement Concept



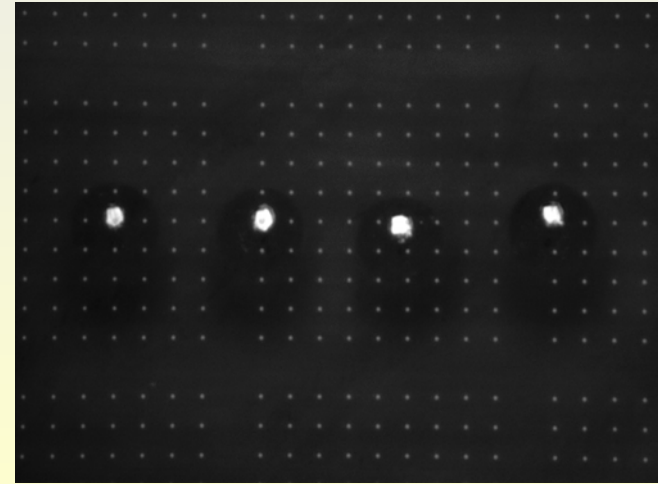
# 3D-OCM: Measurement System



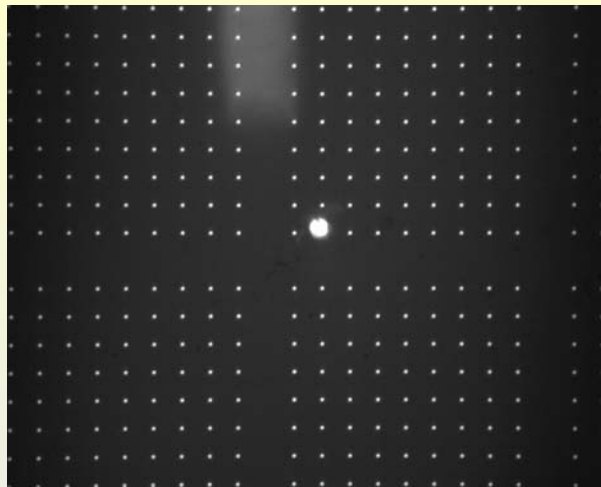
# 3D-OCM: Example Probe Images



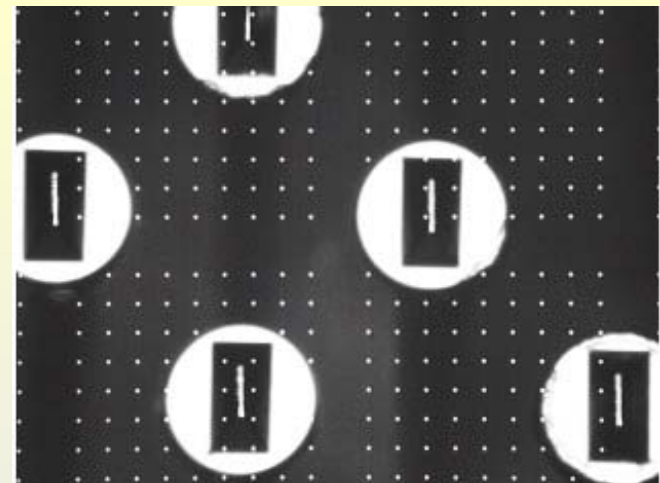
**MicroSpring™**



**Vertical**



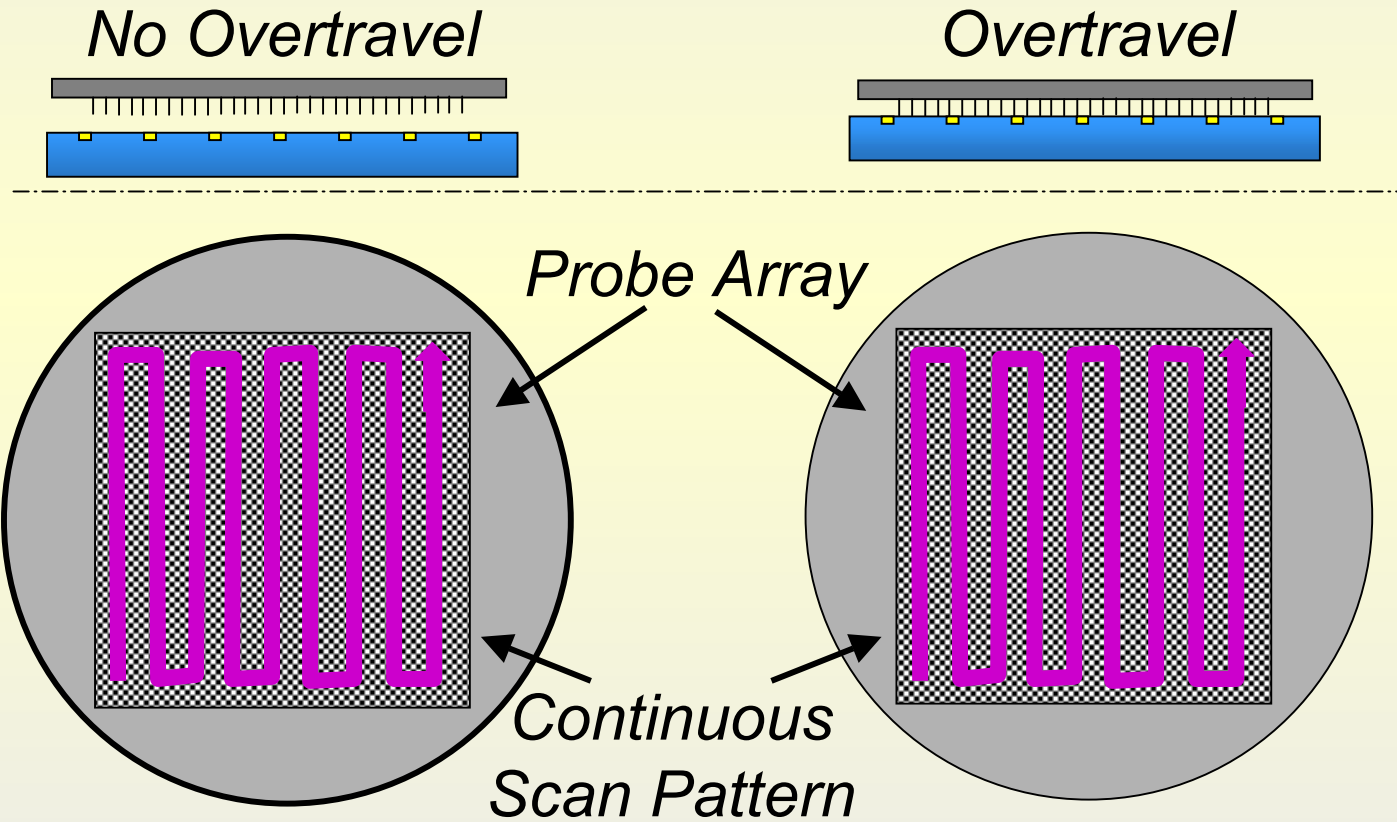
**Cantilever**



**Blade**

# 3D-OCM: Continuous Scan

- Continuous One-Touch Scan
  - Up to 300mm diameter probe array



*Planarity & Alignment of All Probes*

# 3D-OCM: Benefits

## HIGH SPEED

- Fast continuous motion scan of ALL probes
  - Measurement times not slowed down by relays or capacitors
  - Same measurement for bussed & non-bussed probes
- Scan probes at available image capture rates
  - Example: Capture/process images at 10 frames/second
    - 100um pitch linear array (4 probes/capture)
      - 2,000 probes in < 2 minutes
      - 10,000 probes in < 10 minutes
- Electrical measurements can be made in parallel with planarity and alignment measurements

# 3D-OCM: Benefits

## ACCURACY & REPEATABILITY

- Accuracy dependent on NIST traceable mask
- Measurement INDEPENDENT of stage accuracy
  - Eliminates time-consuming stage calibrations
- Measurement standard and probes are co-located
- Directly measure and compensate for system deflection
- Distributed measurement surface – less sensitive to wear and dirt/debris
- Improved Gage R&R results – reproducibility approaching repeatability



# probeWoRx Results

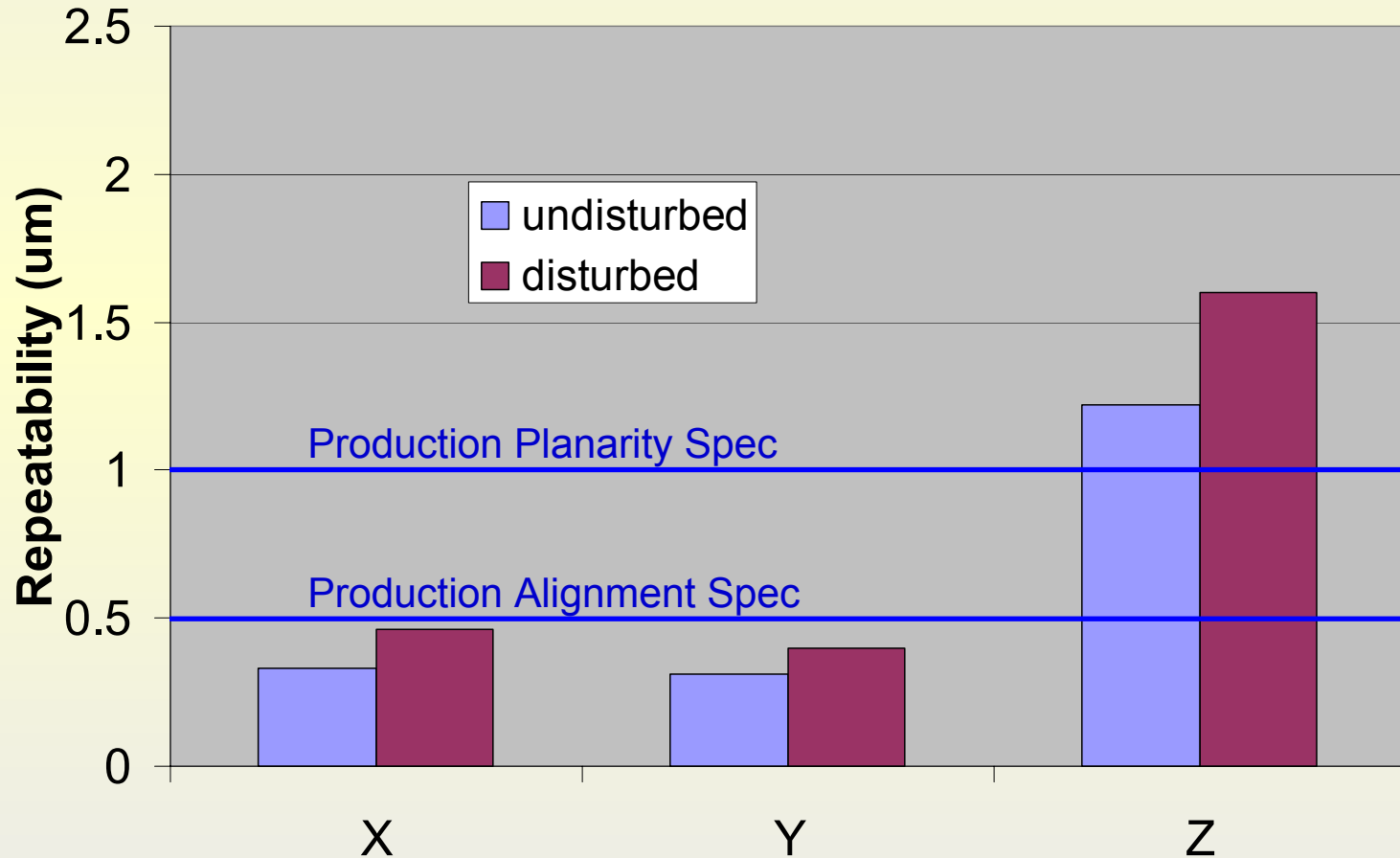
## Planarity and Alignment Test Times

Probe Tip Technology	Total Probes	Array Size (mm)	Total DUTs	PR Test Times (hours)	probeWoRx Test Times (minutes)
Vertical	2596	42 x 61	64	<b>1:43</b>	<b>6</b>
Microspring	6720	98 x 91	194	<b>4:18</b>	<b>22</b>
Cantilever	4480	111 x 45	64	<b>1:22</b>	<b>7</b>

# probeWoRx Results

## Undisturbed and Disturbed Repeatability (3 sigma)

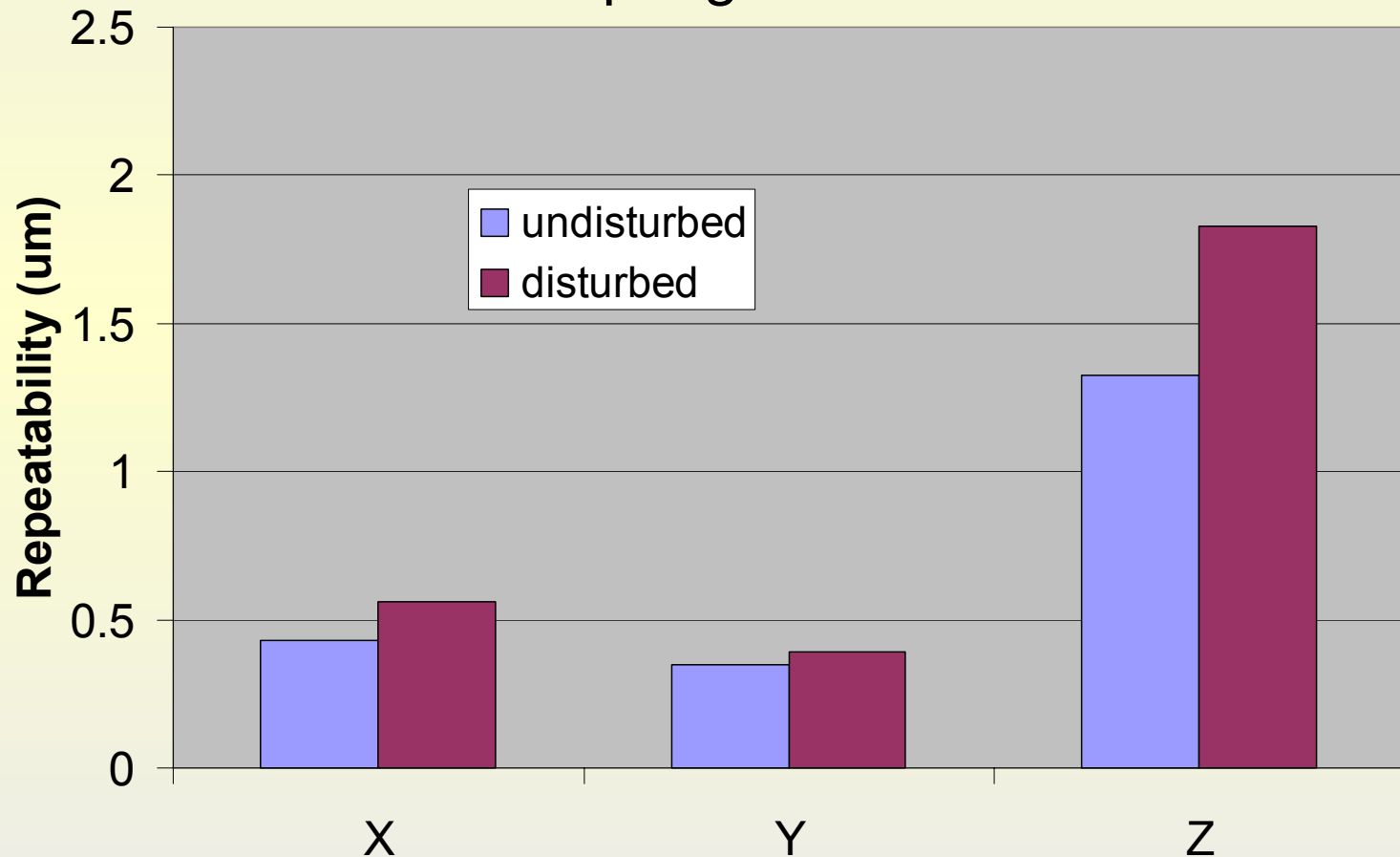
### Cantilever Probe Card



# probeWoRx Results

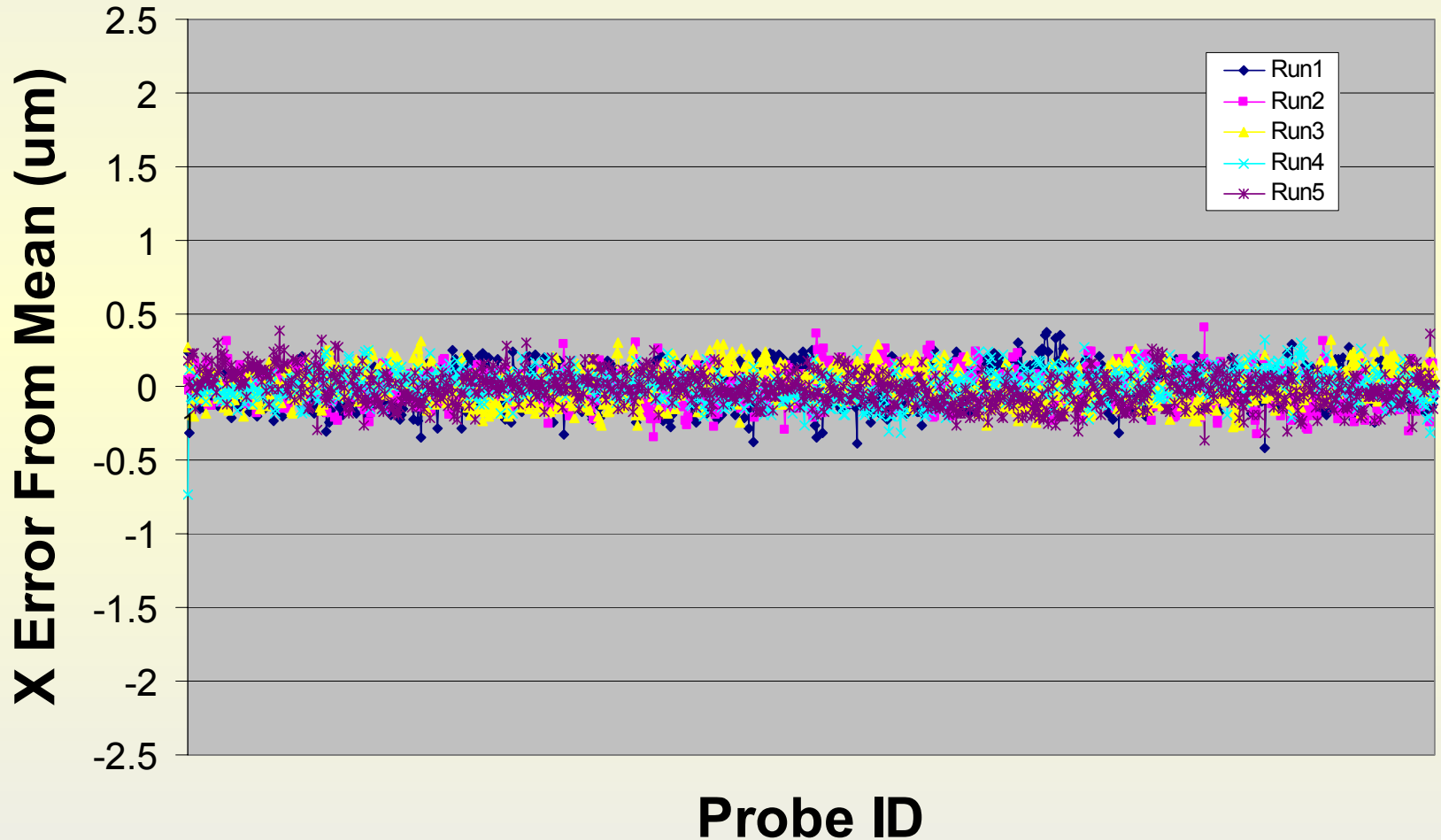
## Undisturbed and Disturbed Repeatability (3 sigma)

### Microspring™ Probe Card



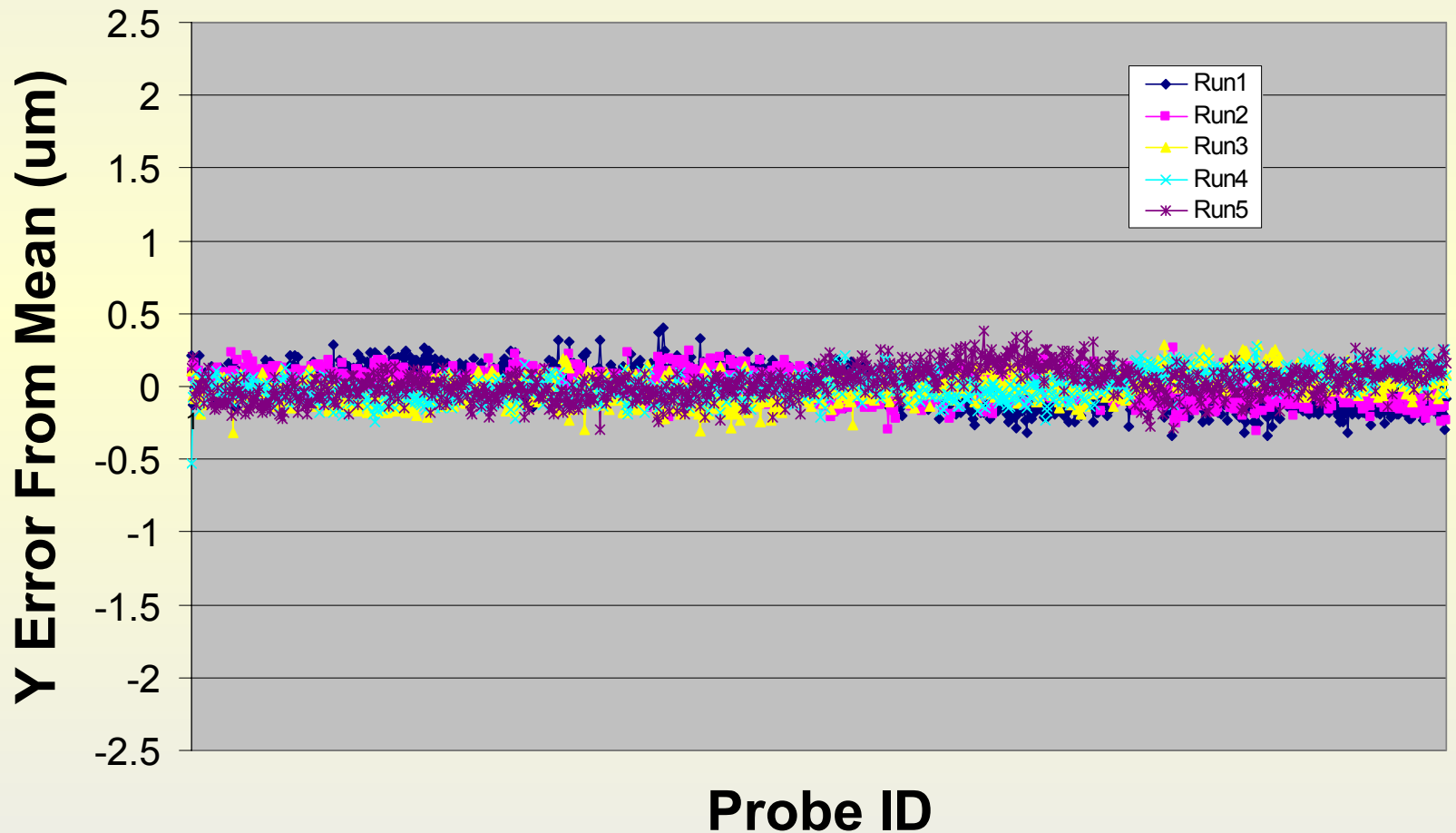
# probeWoRx Results

## X Error Repeatability, Undisturbed



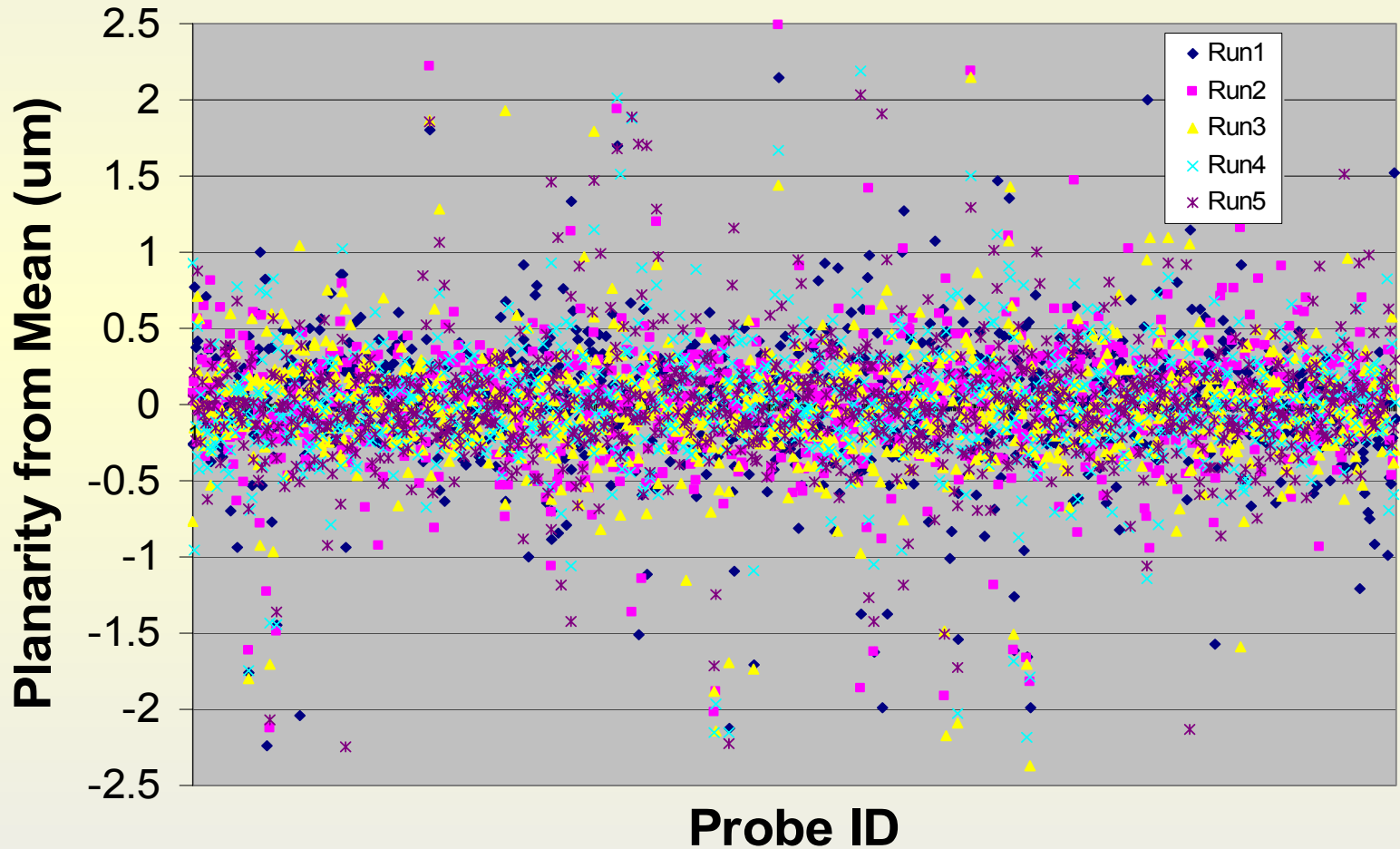
# probeWoRx Results

## Y Error Repeatability, Undisturbed



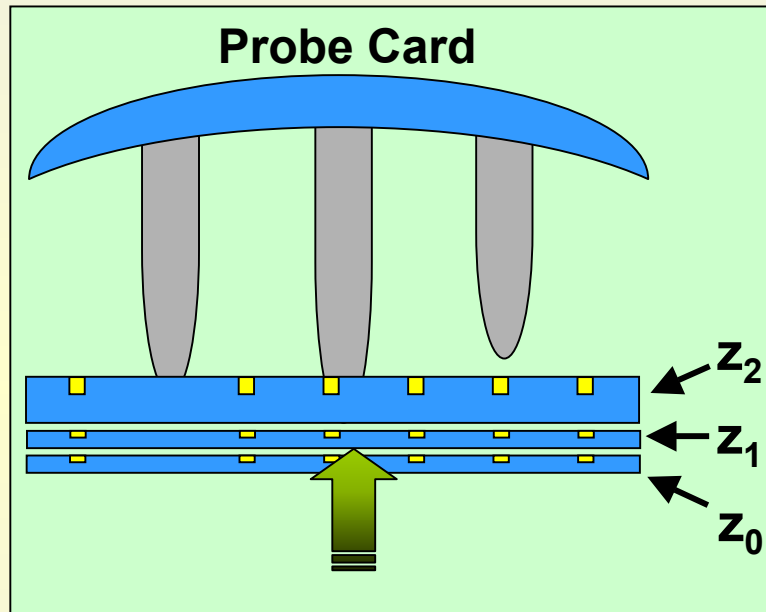
# probeWoRx Results

## Planarity Repeatability, Undisturbed

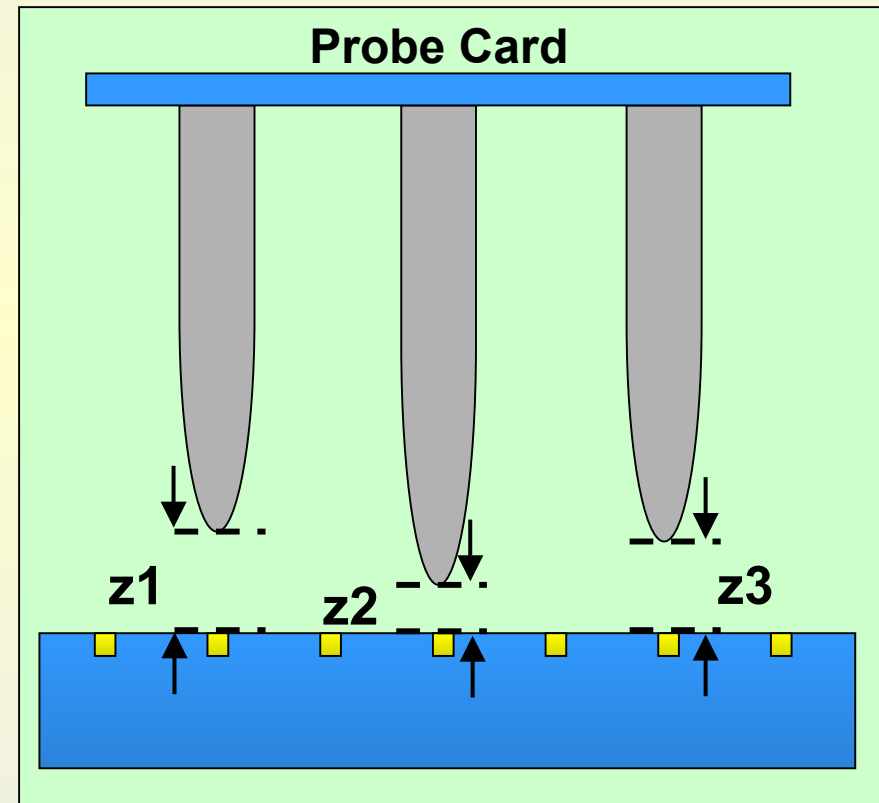


# New Measurement Capabilities

## Planarity with no load



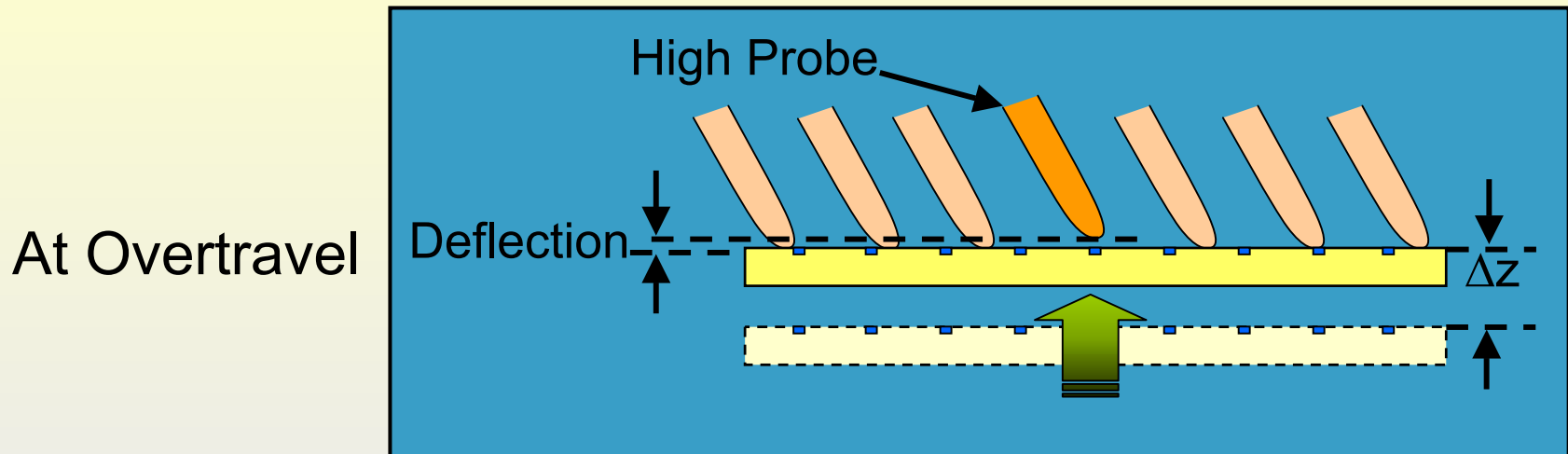
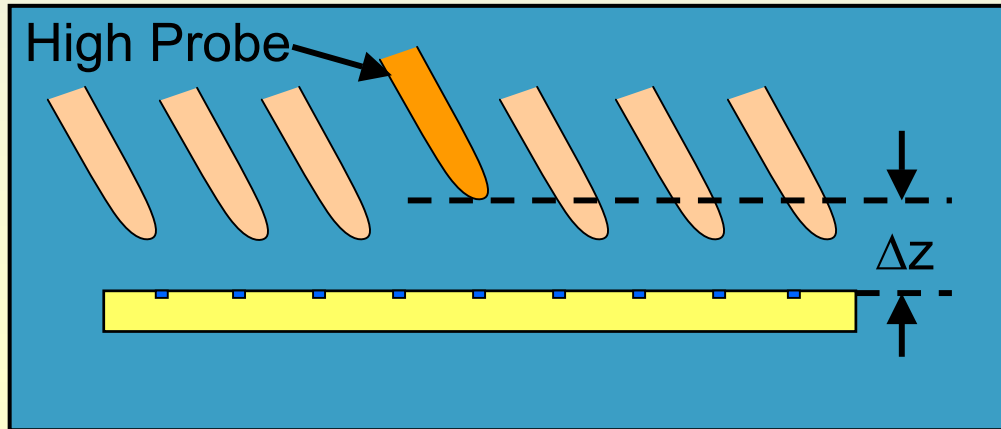
Electrical Planarity



3D-OCM

# New Measurement Capabilities

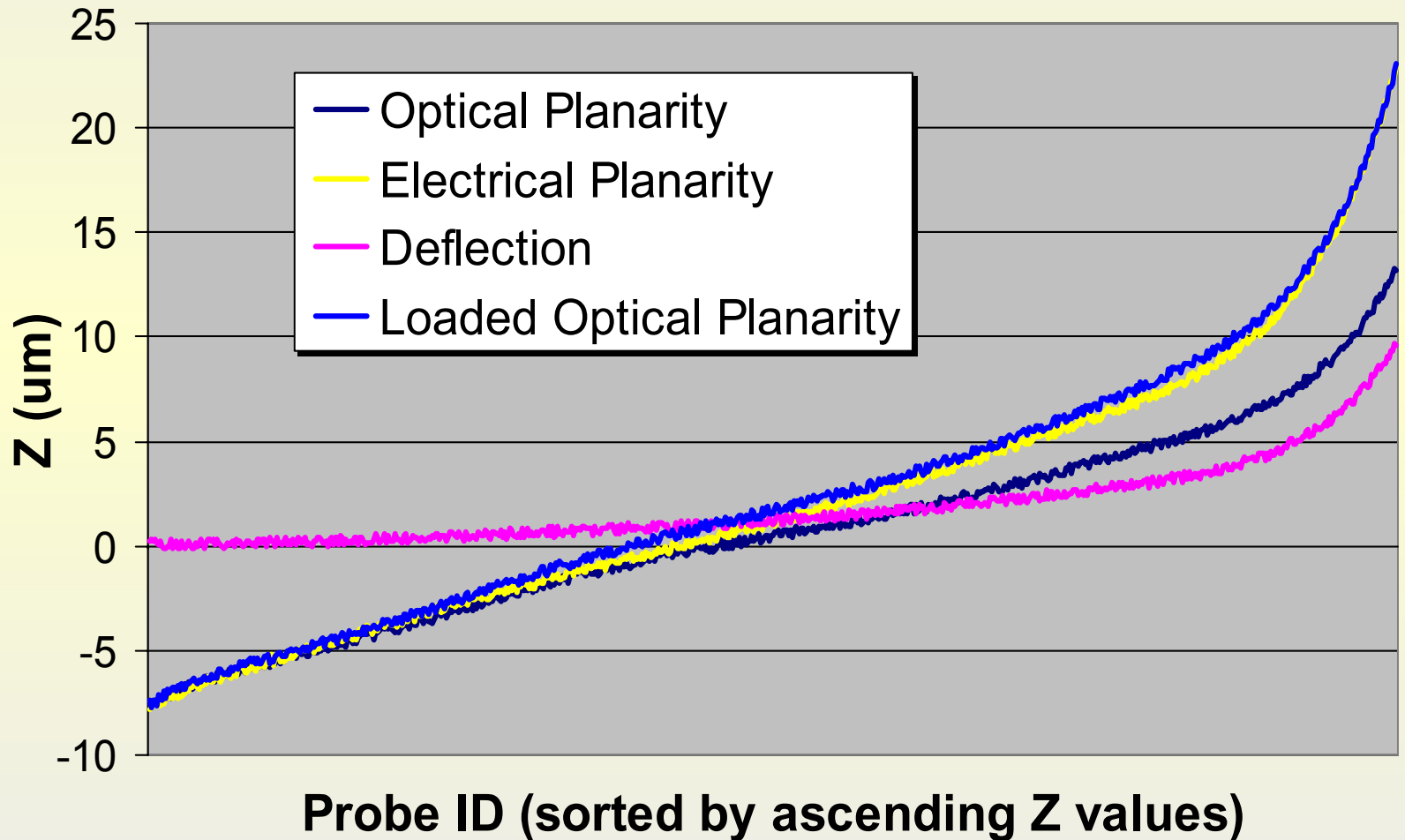
## Probe card/fixture deflection measurement





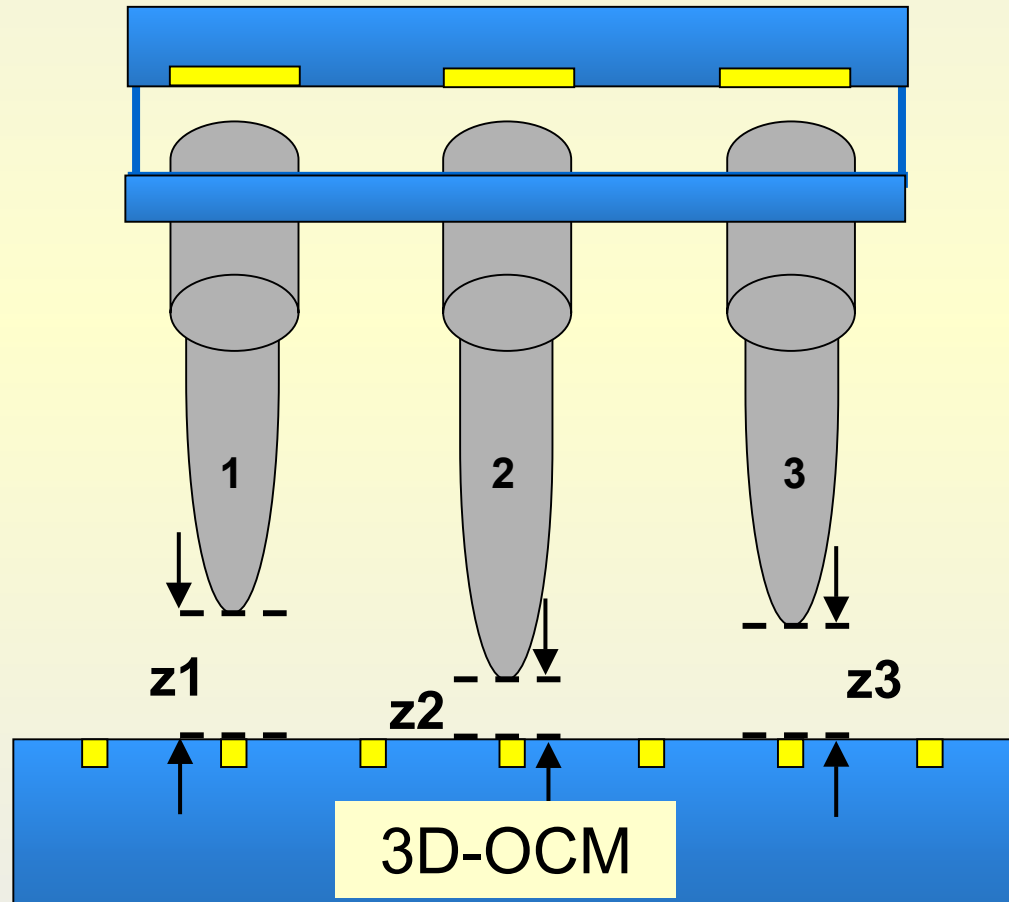
# New Measurement Capabilities

## Loaded Optical Planarity



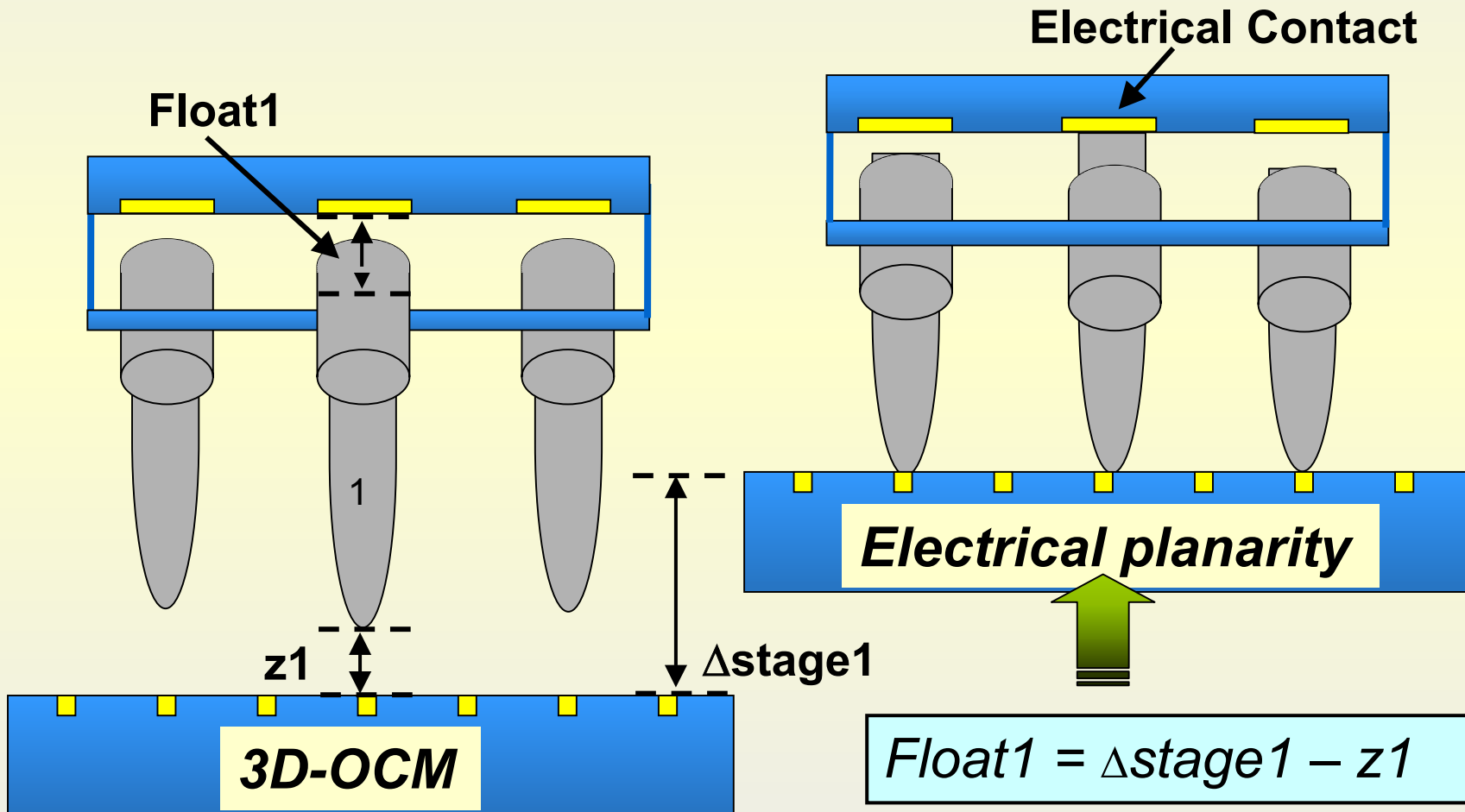
# New Measurement Capabilities

*Measurement of Cobra probe tip planarity in free-hanging position for prober correlation*



# New Measurement Capabilities

- Measurement of Cobra probe tip “float”



# Summary

- Wafer test roadmap demands faster, more accurate metrology
- probeWoRx 3D Optical Comparative Metrology offers significant advantages over current metrology techniques
  - >1 order of magnitude improvement in speed
  - Greater accuracy
  - Higher degree of repeatability and reproducibility
  - Improved machine-to-machine correlation
  - New measurement capabilities