
SW Test Workshop
Semiconductor Wafer Test Workshop

# PCA - Cost of Ownership and Return on Investment

RUDOLPH TECHNOLOGIES

**John Strom**
Senior Fellow

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# Voice of Customer Trips (VoC)

- **What do you want in next generation Probe Card Analyzer (PCA) ?**
  - Asked about Probe Card Roadmaps
    - Array Size
    - Probe Pitch
    - Overtravel Force
    - …
  - Probe Card Analyzer (PCA) test requirements
    - Accuracy – Repeatability
    - Flexibility – Voltages, States
    - New Requirements
    - …

Next Generation PCA

# Voice of Customer Trip (VoC)

- **What did we observed and learned from the visits?**

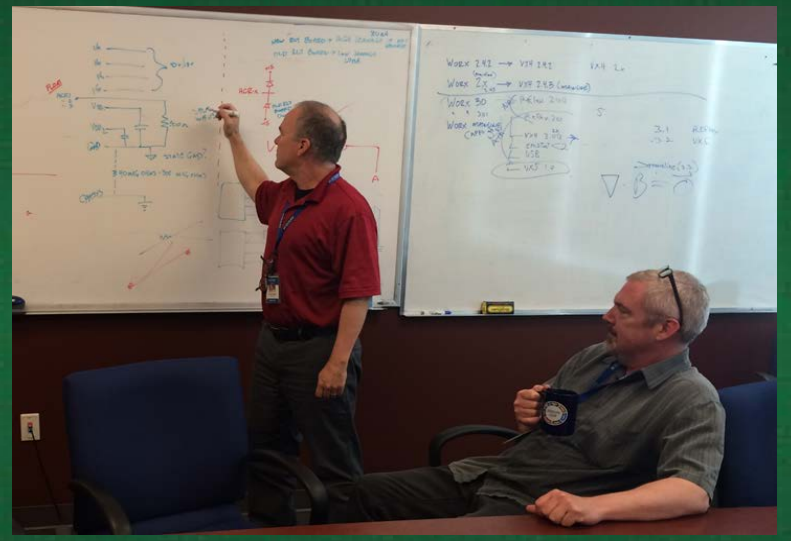
Impressive Probe Card Test Areas!

Lots of customization of the systems

Large Probe Card Interface (PCI) Investment

# After VoC Trips – Discussions

- **How are customers using our systems TODAY**
  - What features are customers NOT utilizing?
  - Are there new alternative testing methodologies that customer may not be aware of?
  - Are customers getting the most out of our PCAs today?
- **Inspiration for this presentation**
  - Can we help you save money today?
  - What alternative testing methodologies can be used today on your current PCAs?



# PCA – Testing Methodology

## How have we historically tested a probe card?

- **Need Probe Card Interface to test (PCI)**
  - Wires up ALL channels of the Probe Card to the PCA
  - Emulates the “Prober Test Head” – Mechanically and Electrically
  - Can be a high cost item.

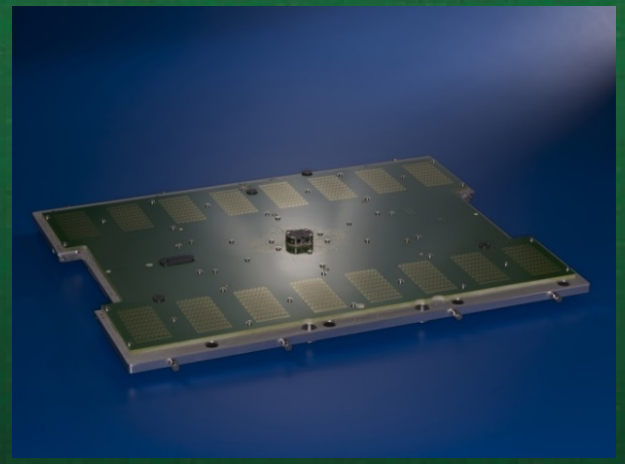
V93K Full Emulation PCI

EMULATES


Tester and Prober Test Head

# PCA – Testing Methodology

- **Install Fully Assembled Probe Card into the Probe Card Interface (PCI)**
- **Install the Probe Card / PCI on a Probe Card Analyzer (PCA)**
  - PCA is fully capable of measuring both Electrical and Mechanical probe card properties
  - Run “Full” test recipes – Measure both Mechanical and Electrical properties of the probe card



Probe Card

Probe Card Interface (PCI)


Probe Card Analyzer (PCA)

# Are There Alternative Test Strategies?

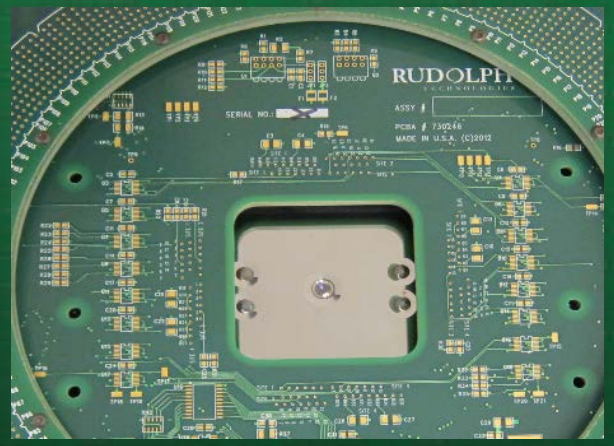
- **Can we challenge the conventional test methodology?**
  - Do we need a fully assembled probe card?
  - Do we need a PCI to test a probe card?
  - Do we need the PCI to fully emulate the prober test head?
  - Do we need a PCA with both Mechanical and Electrical measurement capability?

- **Analyze each one of these test methods**
  - Can we do these alternative test methods and are they valid?
  - What benefit do you get? Does it save you money?

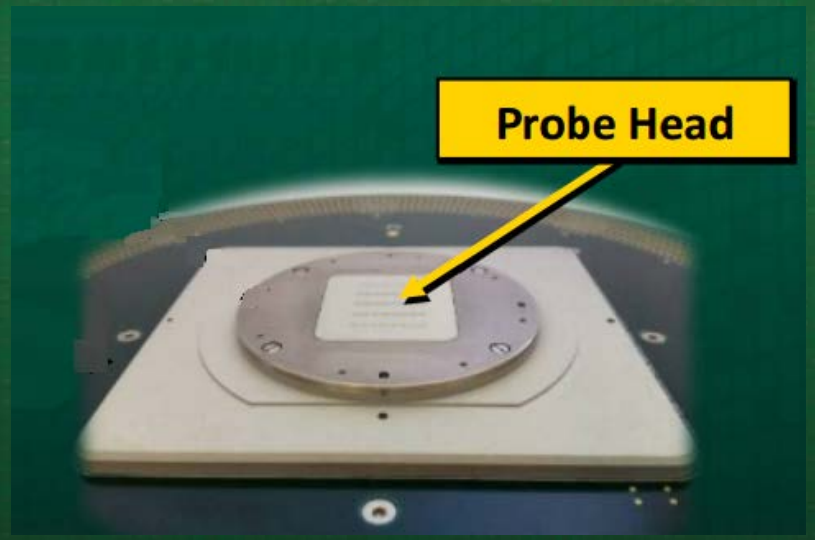
# Modular Testing of a Probe Card

## Do we need a fully assembled probe card?

- **Testing probe card modules**
  - Measure the Bare PCB board before assembly – With or with out components
  - Measure the probe head before assembly (When possible)
  - What kind of tests can I do?



Bare PCB Board – With or Without components

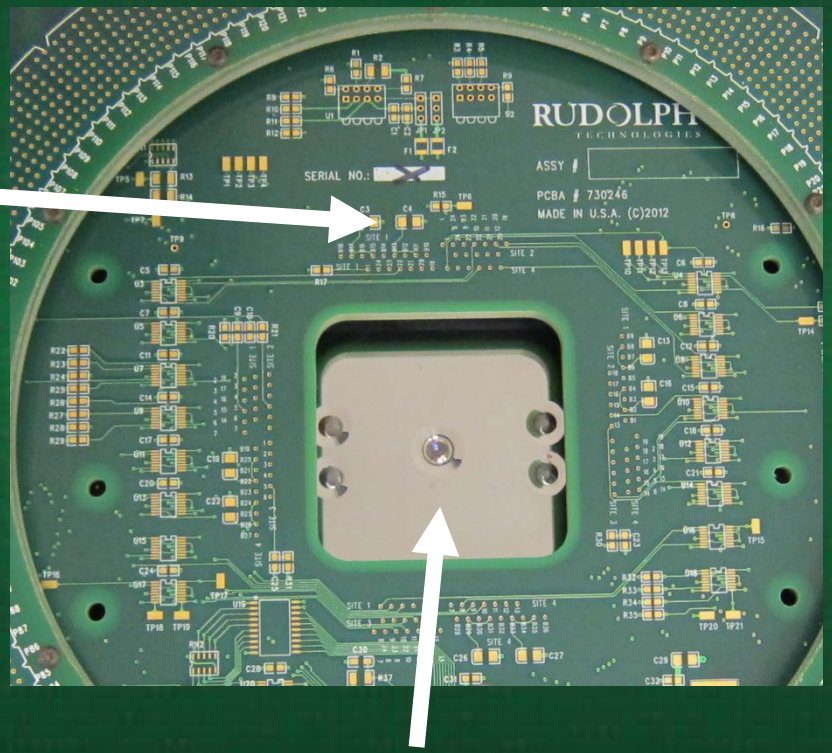



2013 SWTW – SV Probe

# Modular Testing - Bare board Measurements

- **Run all Electrical Tests (With or without Compenents)**
  - Leakage
  - Capacitance, Capacitors
  - Resistors
  - Relays / Components
- **Benefits**
  - Isolate the PCB issues from the probe head
  - Find problems earlier in manufacturing
  - More accurate measurements of the components
  - PCA utilization: Only need to use Electrical Module

**Components – Optional**

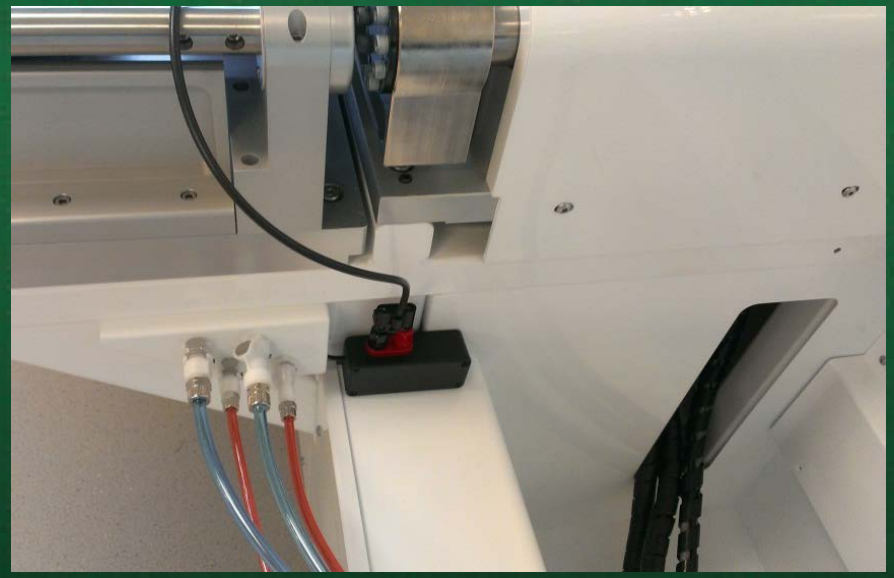



**No probe head installed**

# Module Testing - Probe Card Head

- **How can we test a Probe Card Head?**
  - How do we mechanical connect the probe card head?
  - Hold the probe head via simple fixture. (Probe Card Holder)
- **How do we electrically connect?**
  - Connect the ground plane of the Probe Head to “PCA Ground Connection”

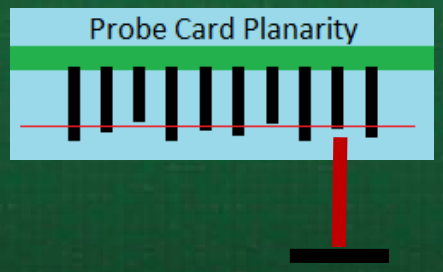

Universal Probe Card Holder

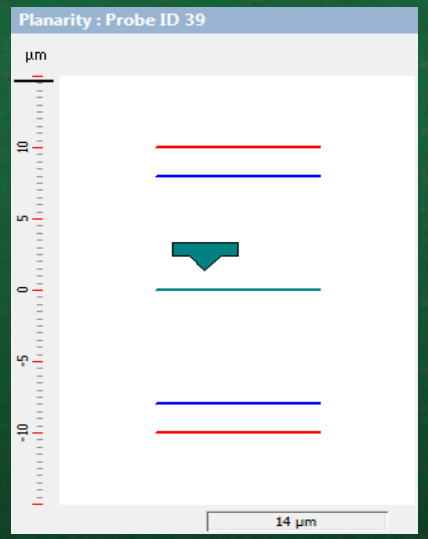


PCA Ground Connection

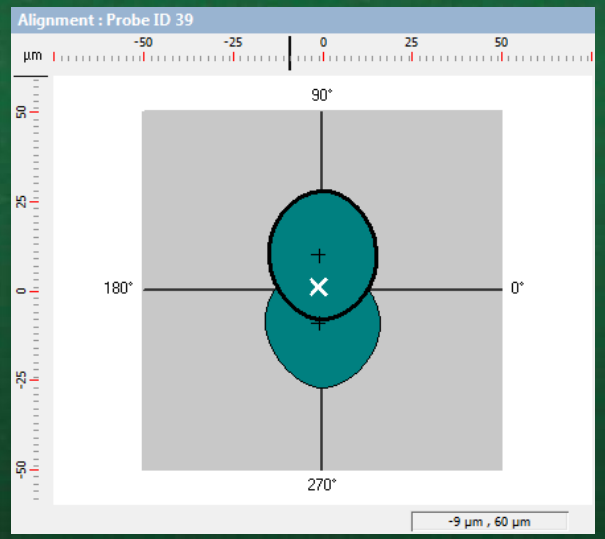
# Module Testing : Probe Card Head

- **What kind of tests can we run on a probe head?**
  - Planarity – Find lowest probe via the ground probes
  - Planarity – Find ALL probe planarity position via isolated posts (Force or Electrical)
  - Alignment – Measure both “No Touch” and “Overtraveled” Positions
  - Probe Force – Measure individual probe spring rates

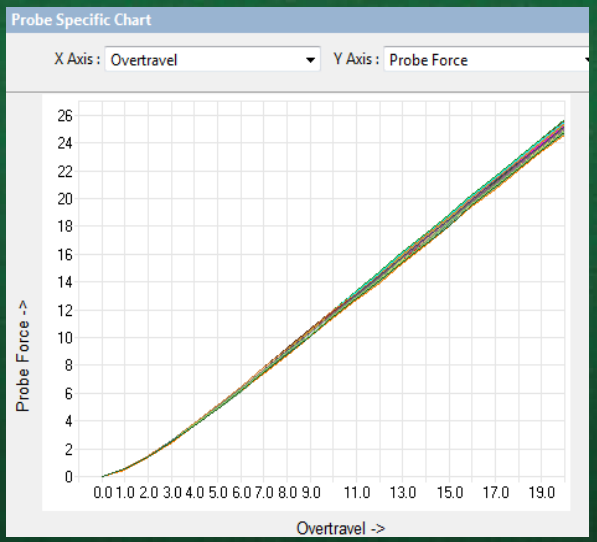



Planarity via Isolated Post




Alignment




Probe Force

# Module Testing - Probe Card Head – Valid?

- **Are the Planarity and Alignment Test Results Valid?**
  - Concerns: Probe Card/Head Holder is not fully emulating the prober test head
  - Concerns: Little PCI Mechanical Stiffness in our test setup
- **How does this affect the Planarity results?**
  - Lets dive in deep and take a look!

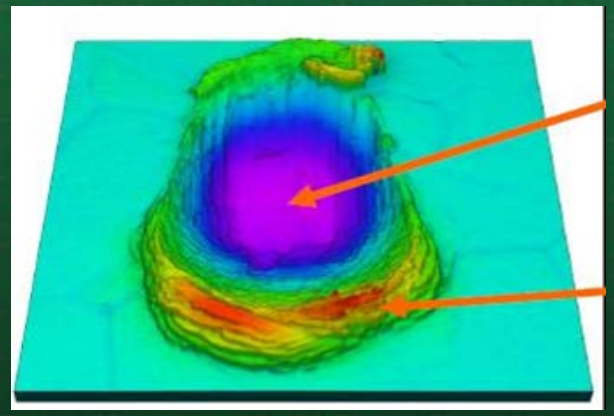

Probe Card Holder

VS.

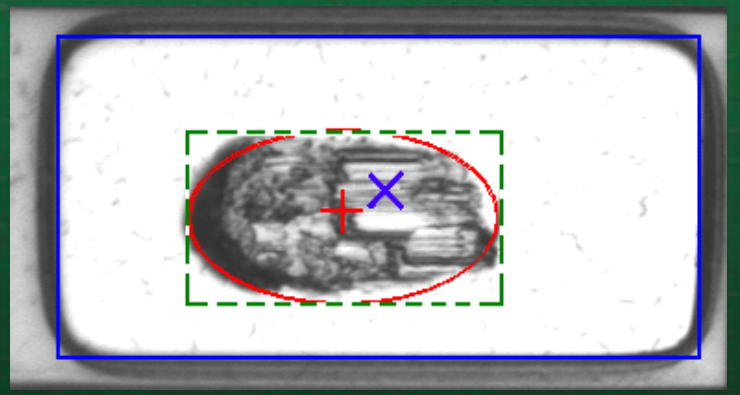
Full PCI Test Head Emulation

# Why do we measure Planarity?

- **A Major Reason: Confidence we will make a good connection with pad / bump**
- **A probe card with good planarity will typically have these properties**
  - Consistent Probe force: Minimizes variations in contact force with the pad or bump
    - Benefit – Helps control consistent Scrub Depth and Contract Resistance
  - Consistent Overtravel of the probe:
    - Benefit - Minimizes the variation of the scrub length.
- **A very important indicator of the quality of the probe card**



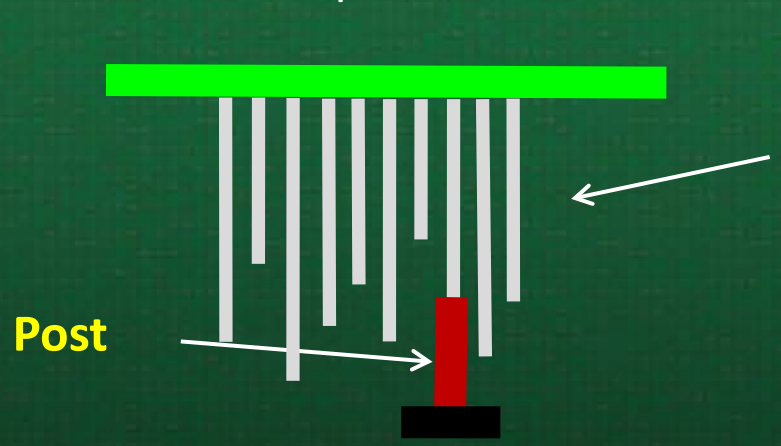
Karklin et al, SWTW 2008



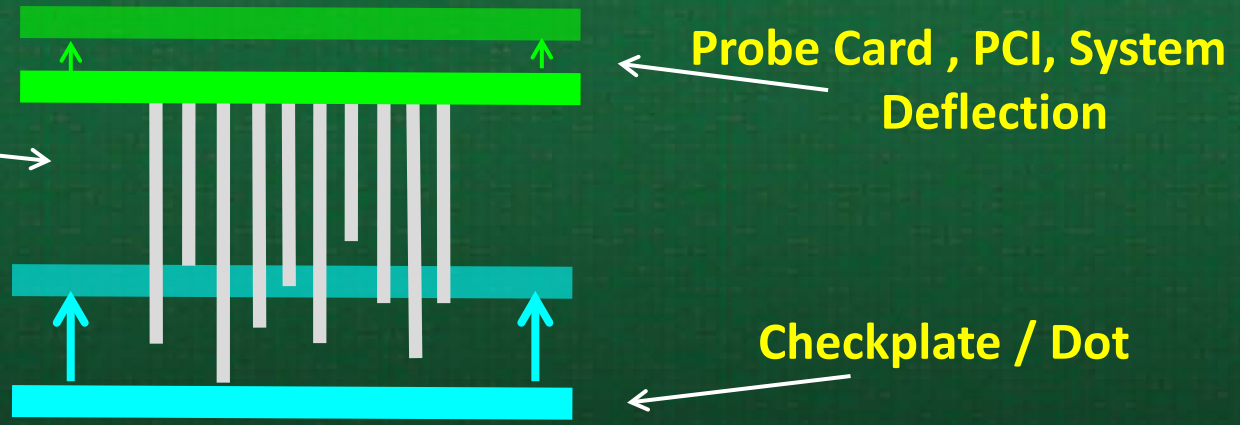
Consistent Scrub length , Depth, Position

# Planarity – PCA - 2 Methods
# No Load vs Loaded

- **No Load Planarity:**
  - Measures probes Z positions in “Free hanging” space typically with the isolated post
  - Optical planarity also measures “Free hanging” space of probes
- **Loaded Planarity:**
  - Measure probes with the Plate / Dot (Emulates how probe card is used on the prober)
  - Measures probes with Deflection



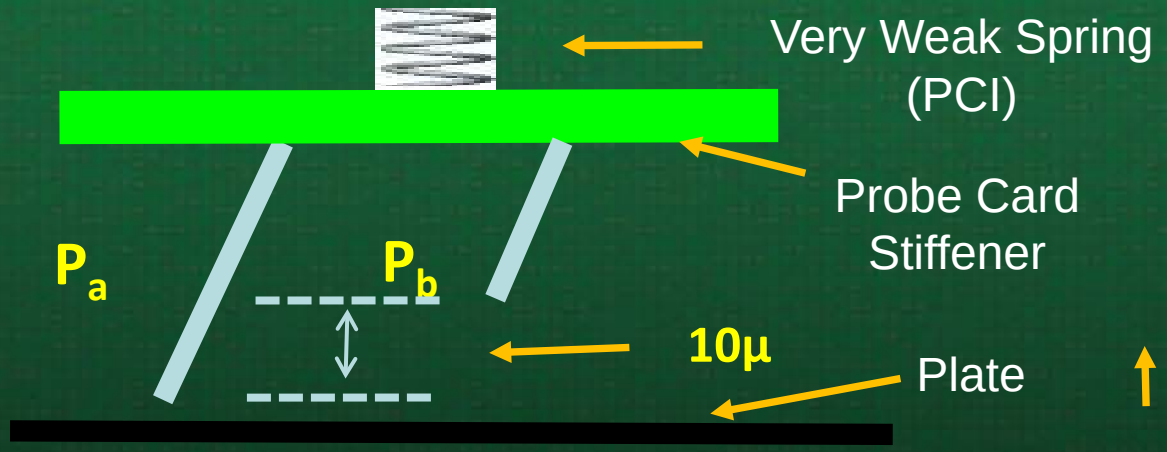

No Load – Isolated Post



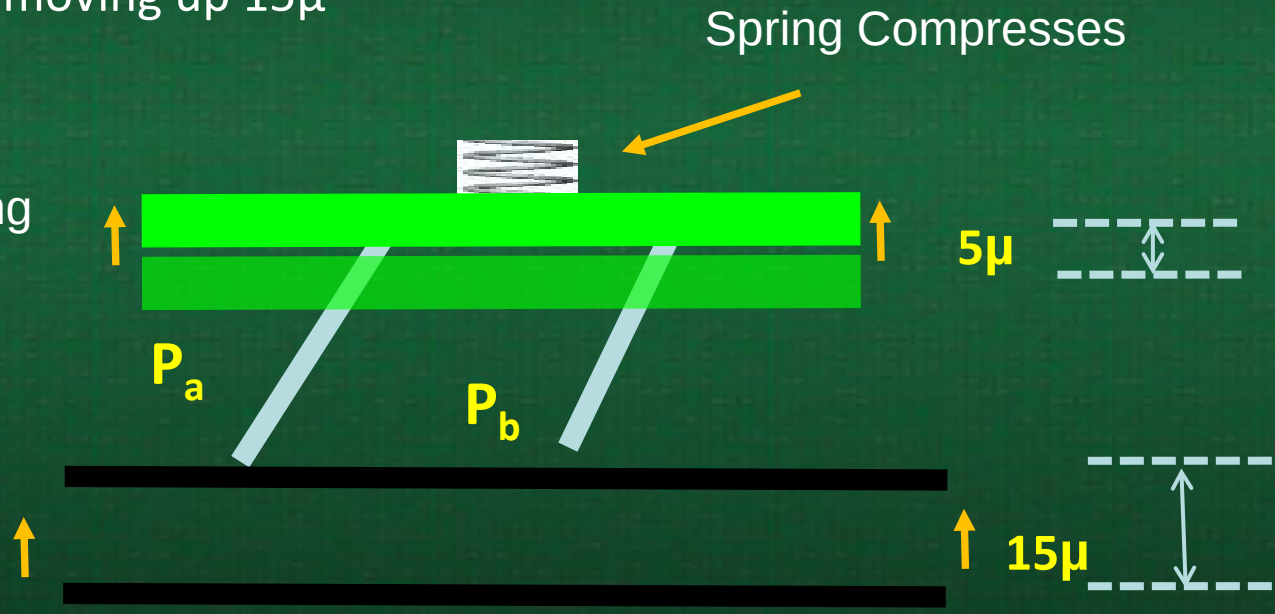

Loaded - Plate

# Planarity – Thought Exercise

- **What planarity method predicts probe variations? (Force, Overtravel, Scrub length…)**
  - Probe card with only 2 probes - Probe A and Probe B – (Rigid Probe Card Stiffener)
  - No Load Planarity Results: Probe A = 0 and Probe B = 10 microns, and held in a probe card holder
- **Measure Loaded Planarity**
  - Move Plate up to touch probe b – Found after moving up 15µ
  - Spring Compresses 5 microns (Pa = 0, Pb = 15)



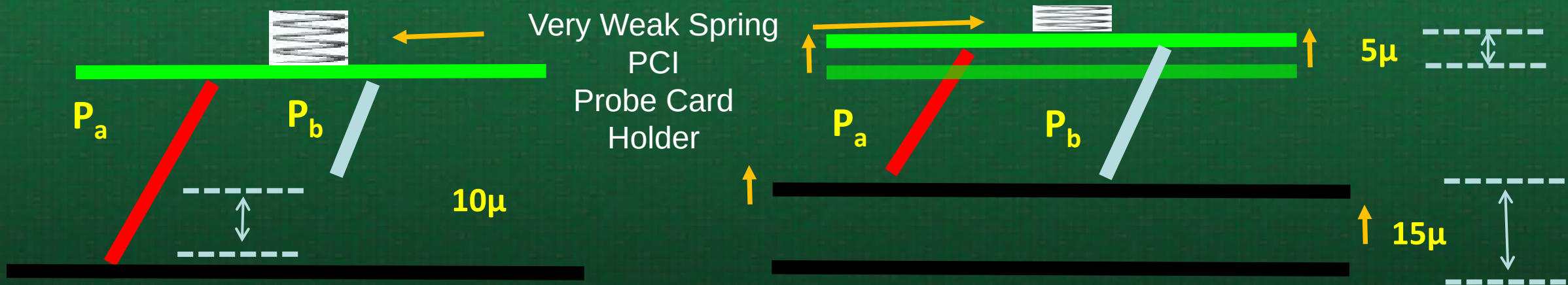

Move plate up until touch Probe A




Measure Probe B with Plate
Drive Z stage up 15 microns

# Planarity – Thought Exercise

- **HOW FAR DID WE OVERTRAVEL PROBE A?**
  - 10 microns! (15 stage overtravel – 5 microns PCI/Probe Card Holder deflection)
  - Probe overtravel variation is EQUAL to the NO-LOAD Planarity Results
  - If you have a rigid probe card stiffener - Probe Overtravel Variation is a function of No-Load Planarity!
    - If your concerned with probe card stiffener deflection – Load Planarity will measure indirectly the warp of the stiffener
  - Probe overtravel variation is largely independent of PCI – probe card holder deflection
  - What planarity method you use is case dependent

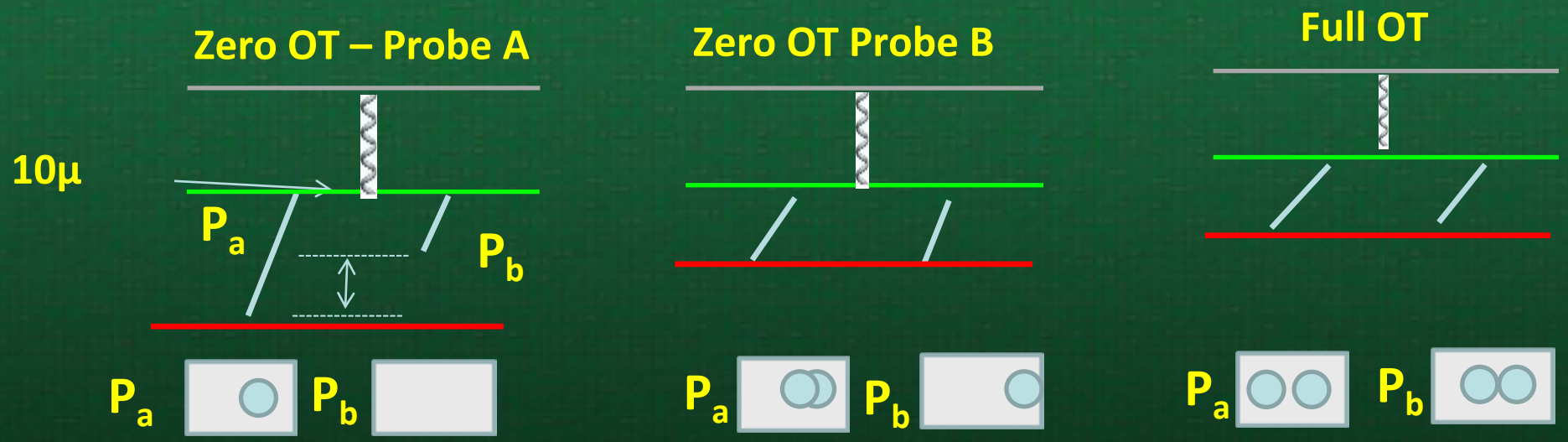



Measure Probe A with Plate

Measure Probe B with Plate
Drive Z stage up 15 microns

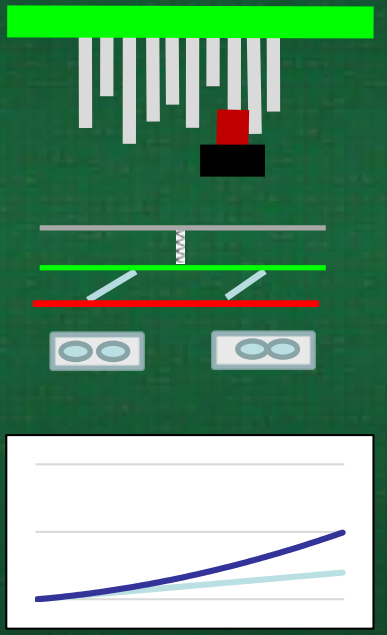
# Alignment – With Probe Card Holder

- **Are Alignment tests results with a probe card holder also valid?**
  - Probe Scrub Length variation is also a function of probe planarity – Same situation
    - NOTE: Individual probes also contribute to scrub length variation. (Scrub rates)
- **Alignment: Scrub Length variation is largely independent of PCI Deflection**
  - Isolating the probe card scrub length variation – (When probe card stiffener is ridged)
  - Case dependent: - You have options



# Probe Head - Summary

- **Yes – We can measure valid Planarity and Alignment results on a probe head!**
  - No Load Planarity directly correlates with overtravel variation of the probes (Largely Independent of Probe Card Holder and System Deflections)
  - No Load Alignment directly correlates with scrub variation of the probes (Largely Independent of Probe Card Holder and System Deflection)
  - Load Planarity = “No Load Planarity” + “All System Deflections”
  - Case dependent: If concerned about probe card stiffener “bowing”

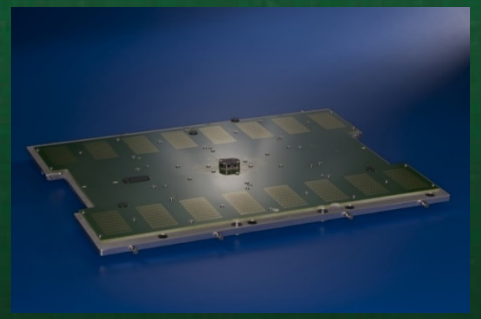


# Do we need a PCI to test a probe card?

- **What did we learn?**
  - You have options on how you want to test your probe cards
  - You can measure with a simple probe card holder and get valid results!
- **Extending the idea – Do we need a PCI to test a probe card?**
  - We have an option to measure with a probe card holder
- **Benefits – Why?**
  - Do quick prototype testing, with out investing in an expensive PCI
  - Get valid Planarity and Alignment results for a very low cost
  - Can even do electrical measurements via User Assist

Note: Probe Card Holder with Probe Card Stiffener

Probe Card



V93K PCI


V93K Probe Card Holder

# Do we need to Fully Emulated PCI?

- **Extending the idea – Can we design PCIs that are simpler. (Lower cost)**
  - How much emulation do you need to get valid results? (Full Emulation – High Cost)
  - Smart Emulation – Lower Cost
  - Optimal PCI Design for your specific use case
- **Benefits**
  - It can save you Money! – Balancing Cost of Test vs. Performance

Fully Emulated V93K Design

VS.

Low Cost – V93K Design

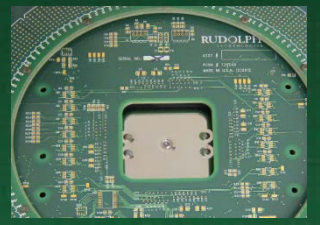
# Do we need to Fully Functional PCA?

- **Extending the idea – Do we need a fully functional PCA?**
  - In some case the system may only need to measure Planarity and Alignment
  - No Pogo Blocks PCA Option
  - An older Low Force PCA can still be used to measure some probe cards (Case dependent)
- **Benefit?**
  - Buy only what you need in your PCA (Lower Cost)
  - Extend the life of your PCAs
  - Optimize the usage of your PCAs
  - Save Money!

# Summary

# Why are alternative Tests Strategies Important?

- **Module Probe Card Testing**
  - Benefits: Can find problems earlier in production, Easier to debug issues…
- **No PCI Testing – Probe Head/ Probe Card Holder**
  - Do quick prototype testing, get valid Planarity and Alignment results at a very low cost
- **Low Cost PCI Design**
  - Balancing Emulation vs. Required performance Do you need full emulation? What is the correct amount of emulation for your probe card design?
- **PCA Functionality - Usage**
  - Only buy what is needed
  - Optimize the lifetime of the system by understanding what is required in your PCA
- **SAVE MONEY!**




# What's Next?

- **We will continue to sell, improve and support the current VX4!**
- **Next generation tool is being designed to meet NEW market requirements**


Current VX4 PCA

Next Generation Tool

# Thank You - Questions


- **Acknowledgements**
  - Craig Connolly - RTEC
  - Greg Olmstead – RTEC
  - Bill Favier - RTEC