



SW Test Workshop
Semiconductor Wafer Test Workshop

PCA - Cost of Ownership and Return on Investment

RUDOLPH
TECHNOLOGIES

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Voice of Customer Trips (VoC)

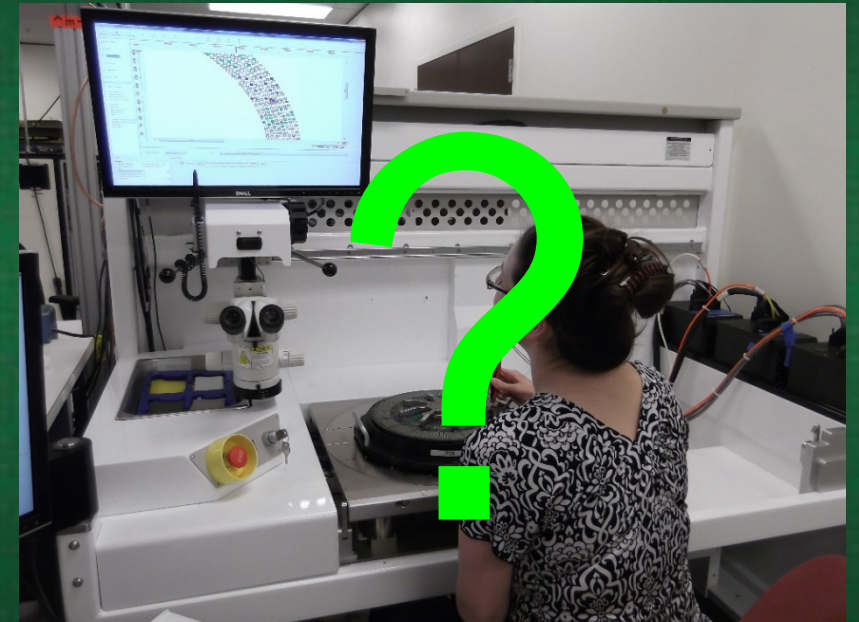
- **What do you want in next generation Probe Card Analyzer (PCA) ?**

- 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

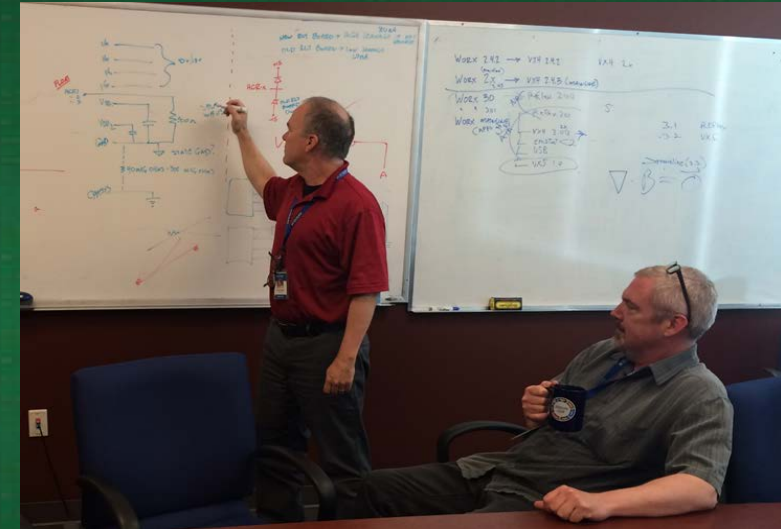
After VoC Trips – Discussions

- **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**

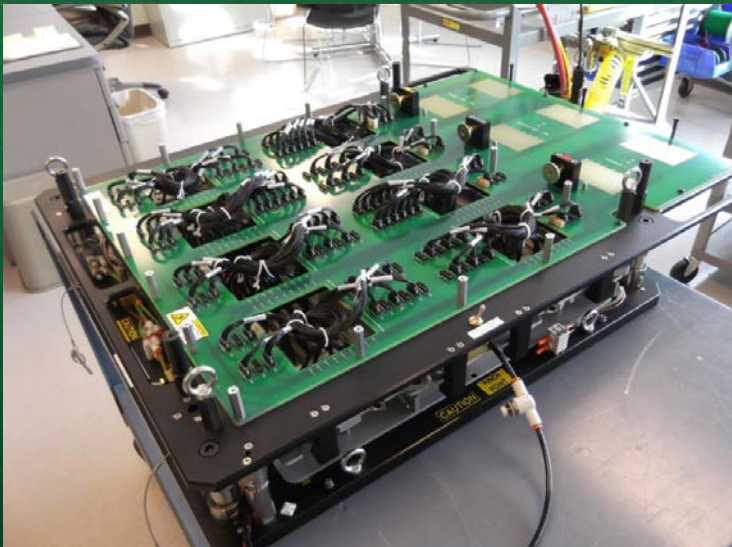
- Can we help you save money today?
- What alternative testing methodologies can be used today on your current PCAs?



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

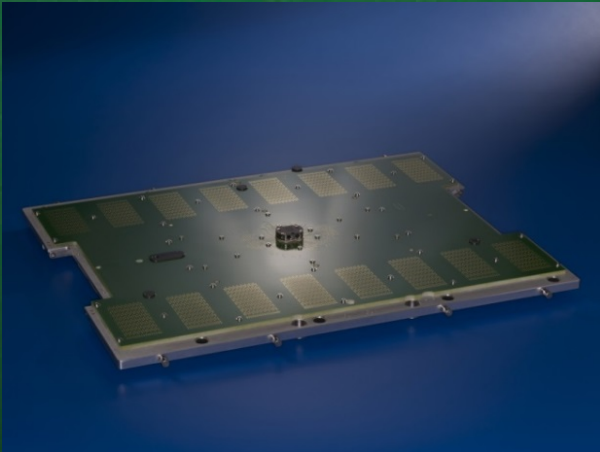
EMULATES



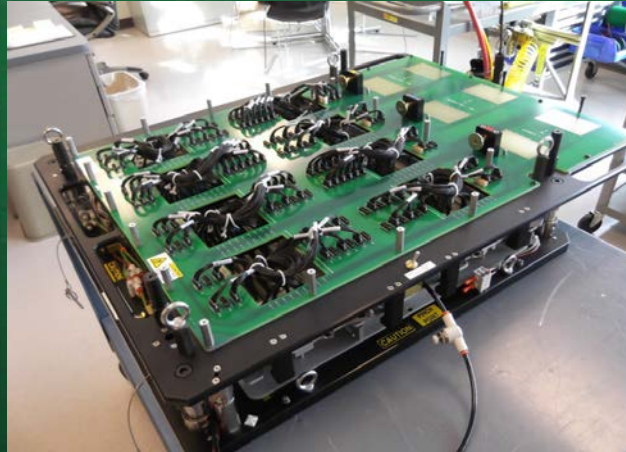
Tester and Prober Test Head

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)

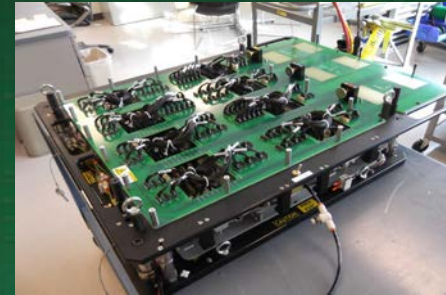


Probe Card Analyzer (PCA)

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?

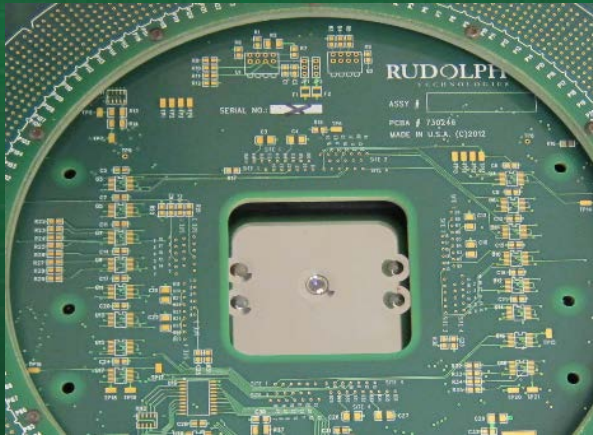


Modular Testing of a Probe Card

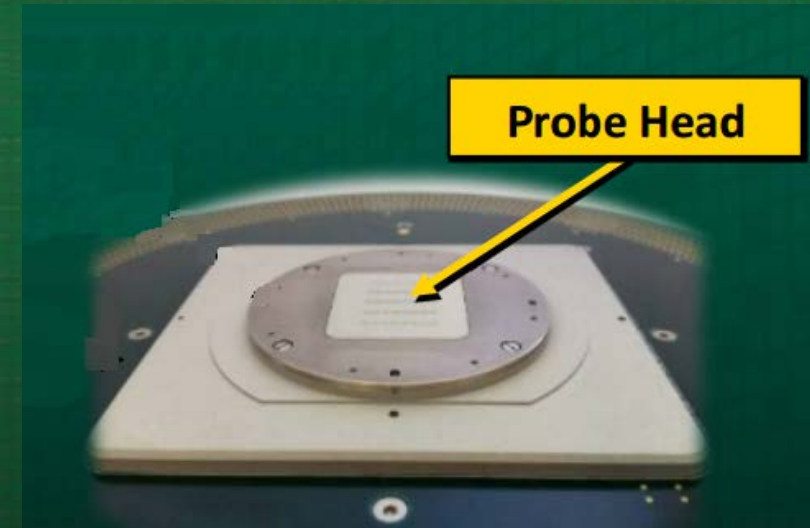
Do we need a fully assembled probe card?

- **Testing probe card modules**

- Measure the Bare PCB board before assembly – With or without 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

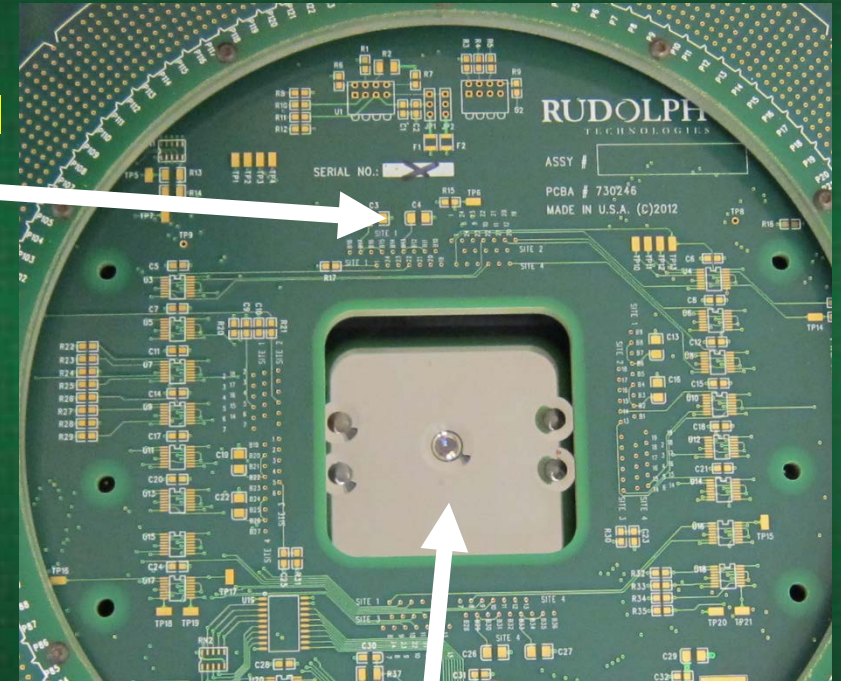
- **Run all Electrical Tests (With or without Components)**

- Leakage
- Capacitance, Capacitors
- Resistors
- Relays / Components

Components – Optional

- **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



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

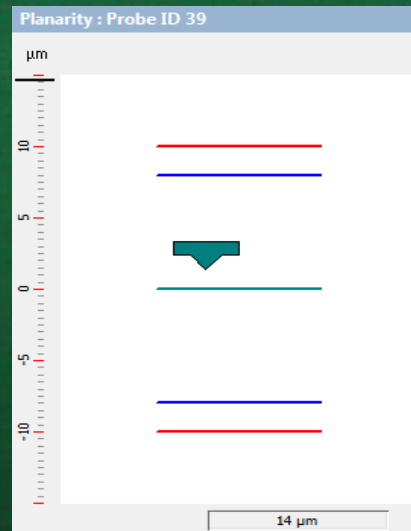
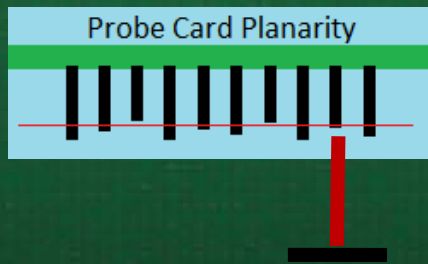


PCA Ground Connection

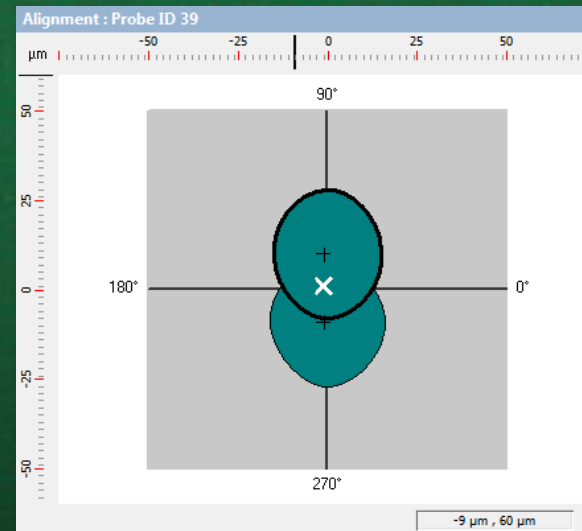
Module Testing : Probe Card Head

- **What kind of tests can we run on a probe head?**

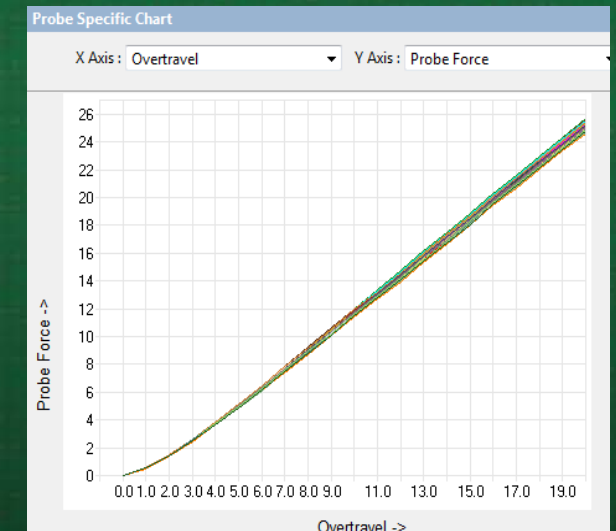
- Planarity – Find lowest probe via the ground probes
- Planarity – Find ALL probe planarity position via isolated posts (Force or Electrical)
- Alignment – Measure both “No Touch” and “Overtraveled” Positions
- Probe Force – Measure individual probe spring rates



Planarity via Isolated Post



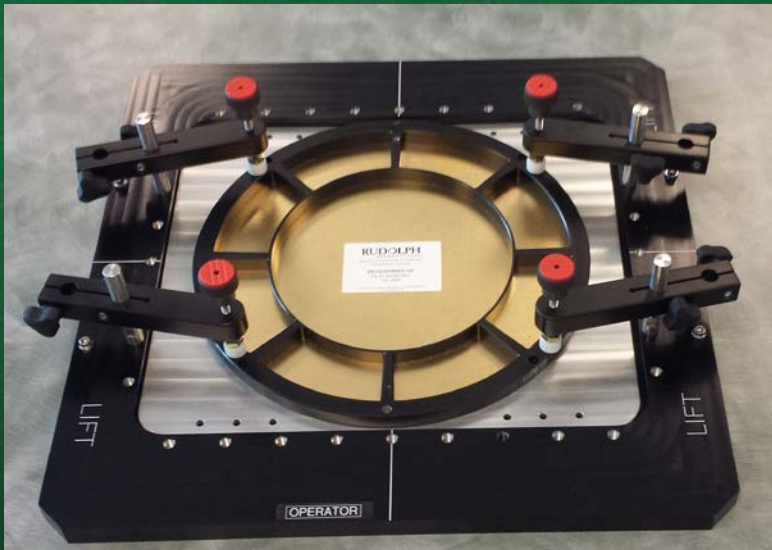
Alignment



Probe Force

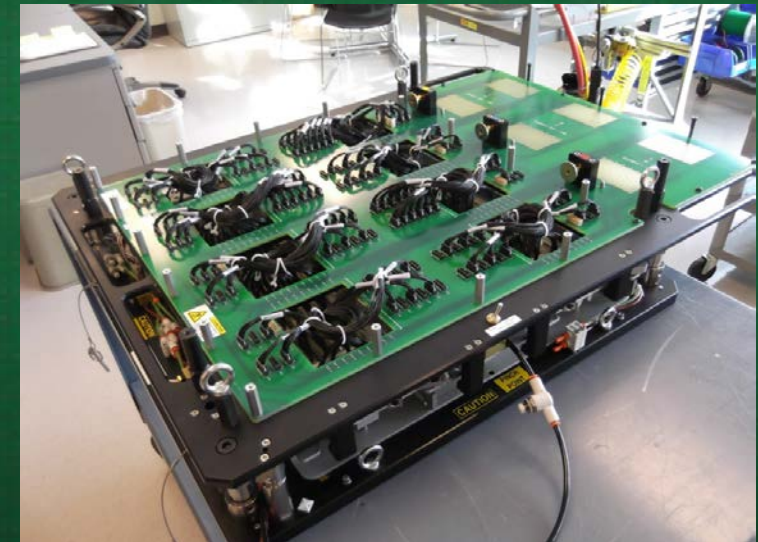
Module Testing - Probe Card Head – Valid?

- **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

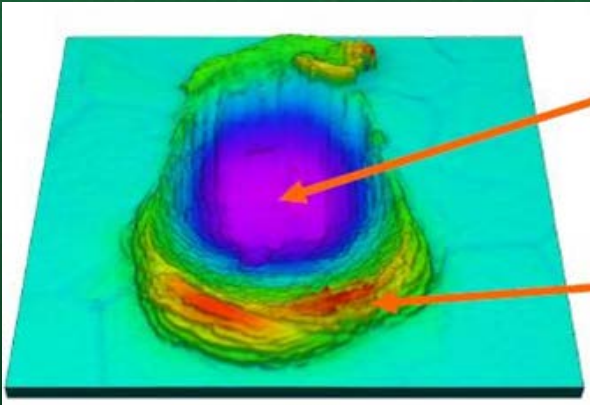
VS.



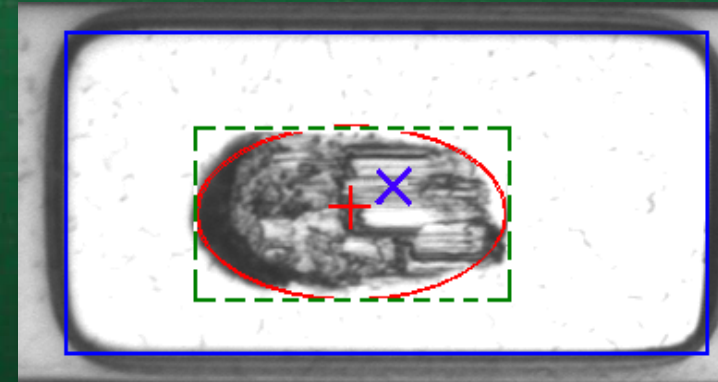
Full PCI Test Head Emulation

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

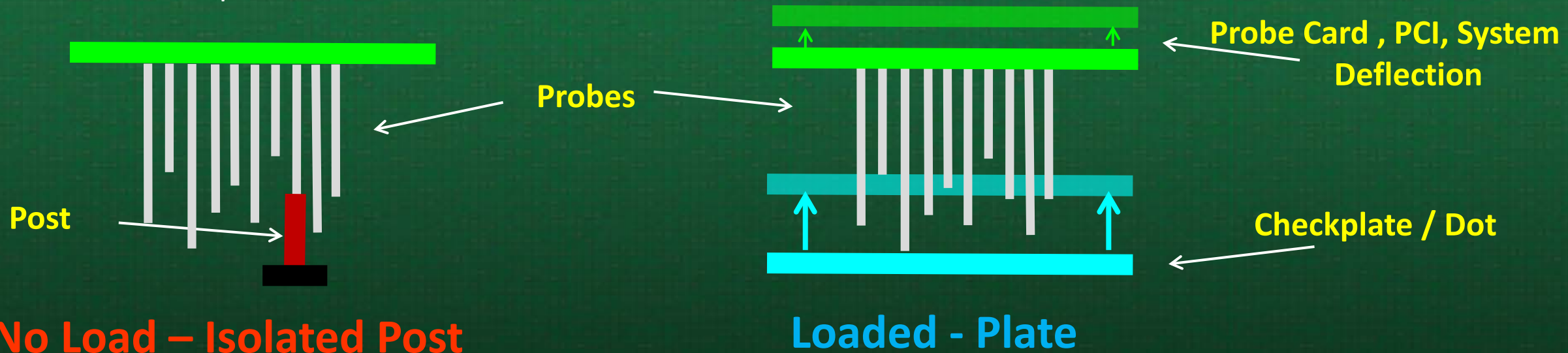
No Load vs Loaded

- **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

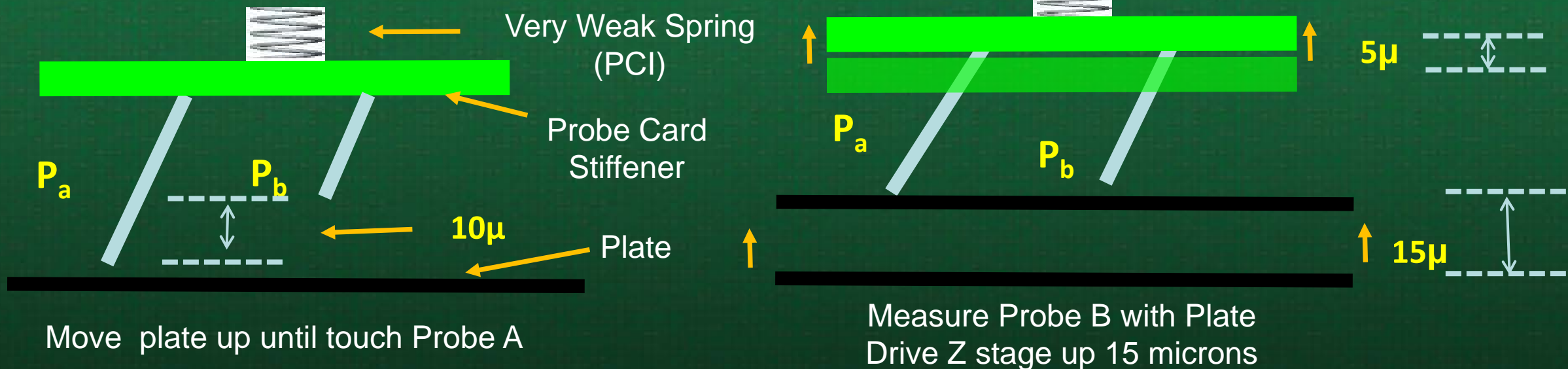
- **Loaded Planarity:**

- Measure probes with the Plate / Dot (Emulates how probe card is used on the prober)
- Measures probes with Deflection



Planarity – Thought Exercise

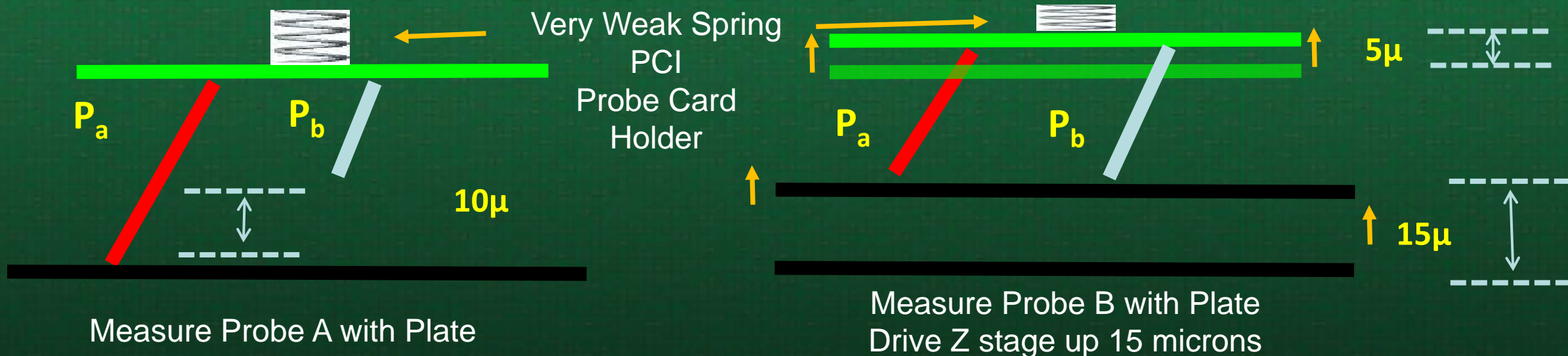
- **What planarity method predicts probe variations? (Force, Overtravel, Scrub length...)**
 - Probe card with only 2 probes - Probe A and Probe B – (Rigid Probe Card Stiffener)
 - No Load Planarity Results: Probe A = 0 and Probe B = 10 microns, and held in a probe card holder
- **Measure Loaded Planarity**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



Planarity – Thought Exercise

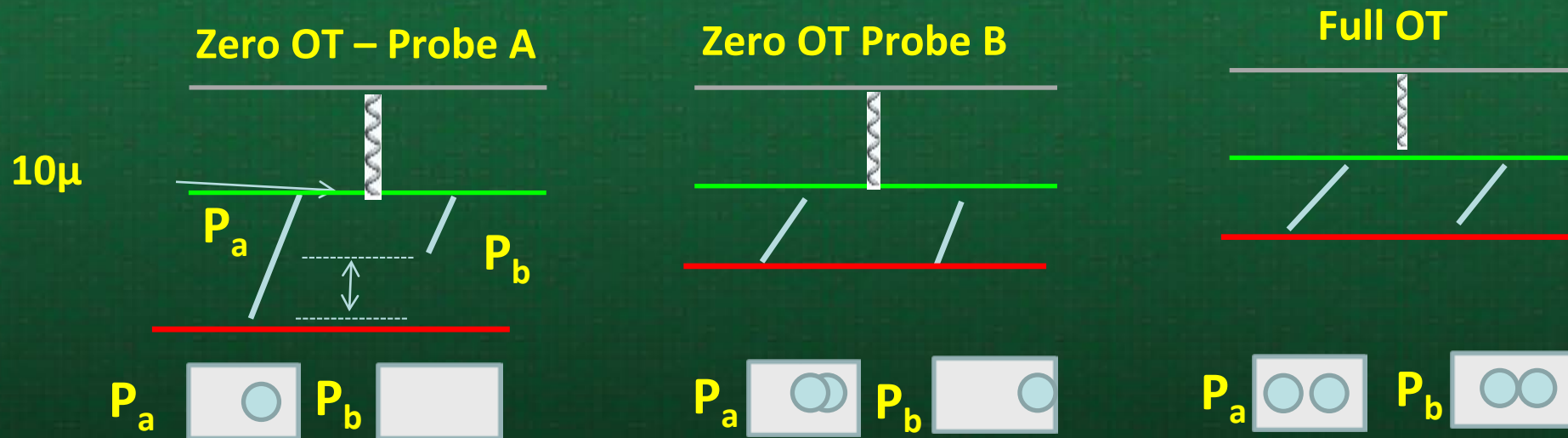
- **HOW FAR DID WE OVERTRAVEL PROBE A?**

- 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



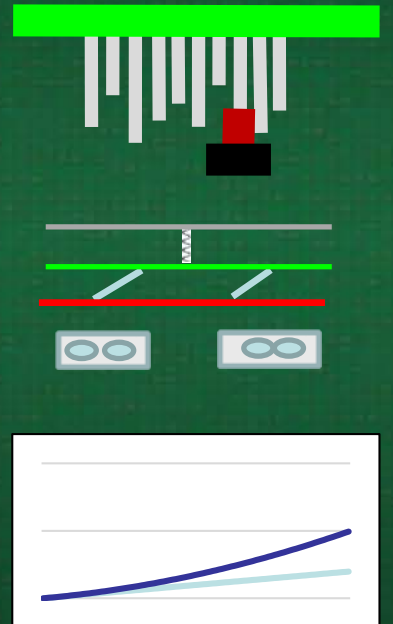
Alignment – With Probe Card Holder

- **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?**

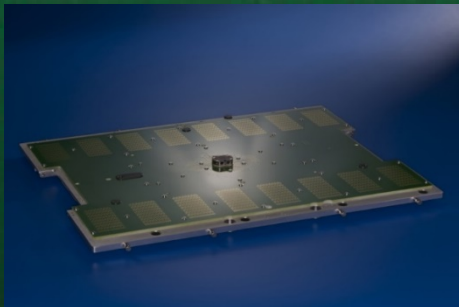
- We have an option to measure with a probe card holder

- **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

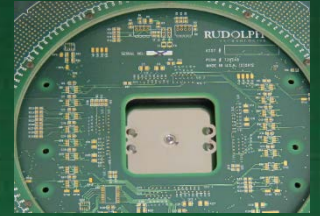
- **Low Cost PCI Design**

- 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
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