

Comprehensive Approach to Control Contact Resistance Instability and Improve First Pass Yield of Bumped Devices

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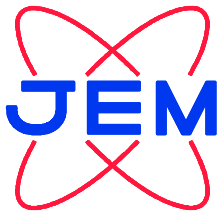
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The logo for Altera Corporation features the word 'ALTERA' in a bold, blue, sans-serif font. The letters are outlined in a darker blue, giving the logo a three-dimensional, blocky appearance.



2005 SouthWest Workshop
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Overview

- Introduction
- Objectives / Approach
- Methodology Overview
- Implementation / Characterization
- Summary

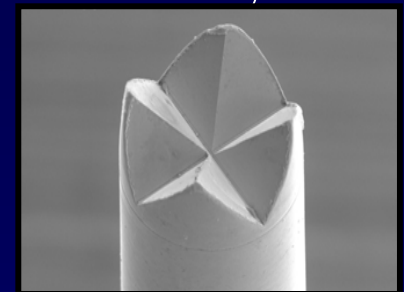
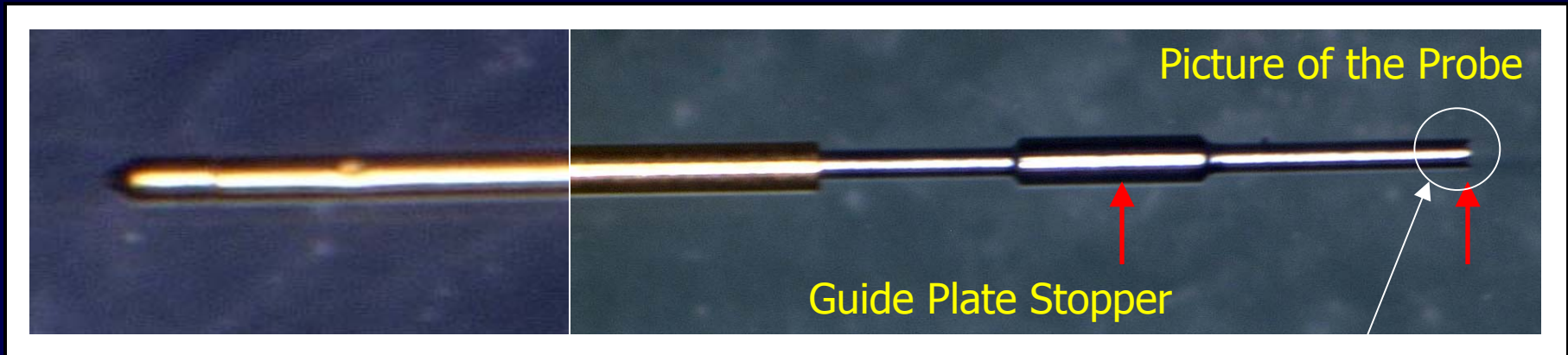
Evaluation Goals

- To determine the initial time zero path resistance of the VS crown probe card, and monitor that same path resistance after various amounts of die had been sorted.
- To compare the performance of current standard VS flat tip technology against the new VS crown tip in terms of wafer yield.

VS-Series Probe (Crown)

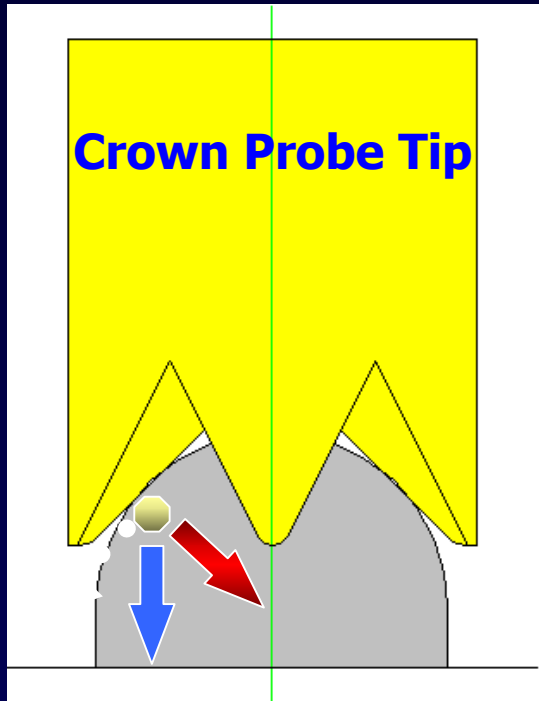
VS Series

- Newly developed spring probe design
- Achieves precise probe position and planarity



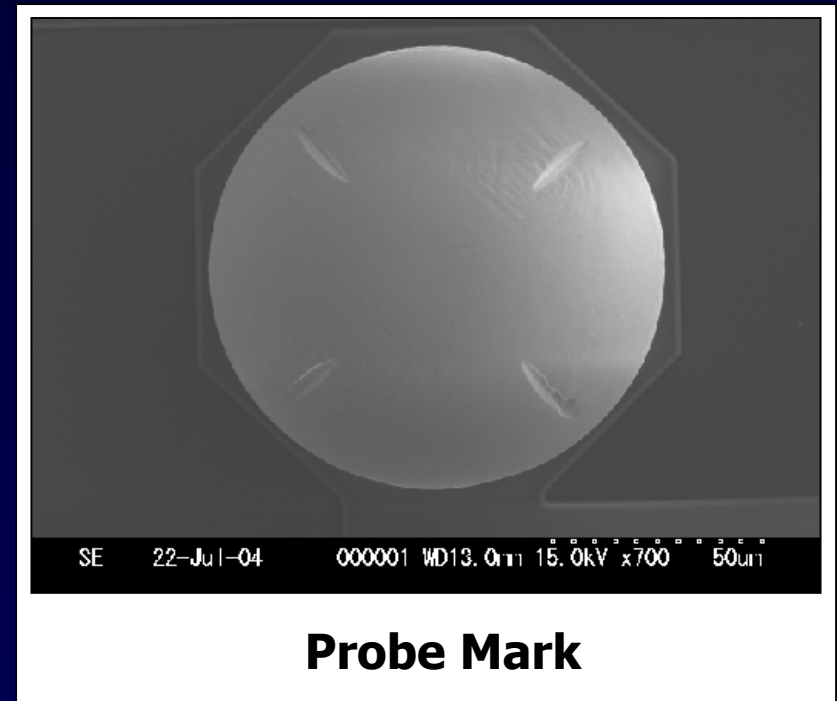
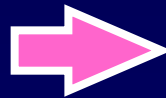
Crown Tip Shape

Contact Concept



**Image of the
Contact Point**

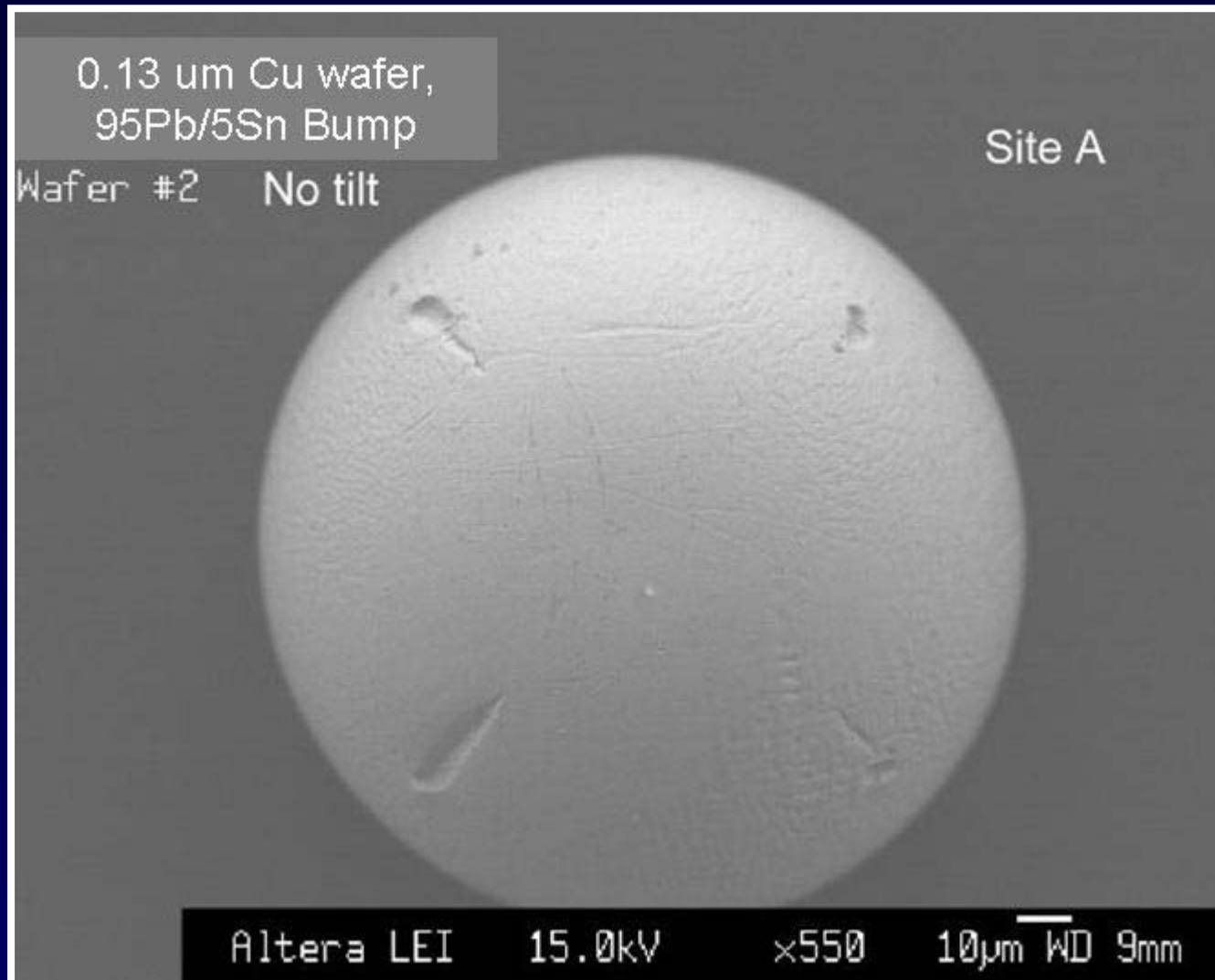
**The ridge of the crown
probe tip translates vertical
force into radial force.**



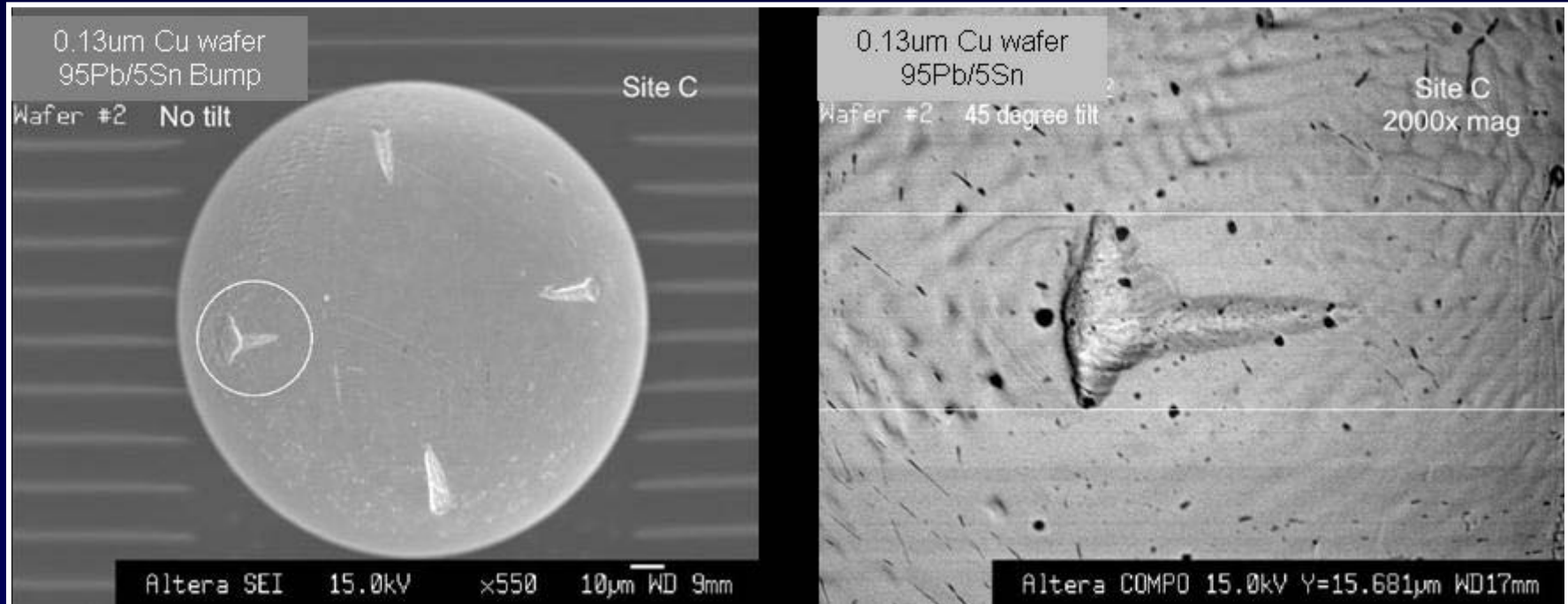
Probe Mark

**Stable CRES by lower
contact force with
minimal probe mark.**

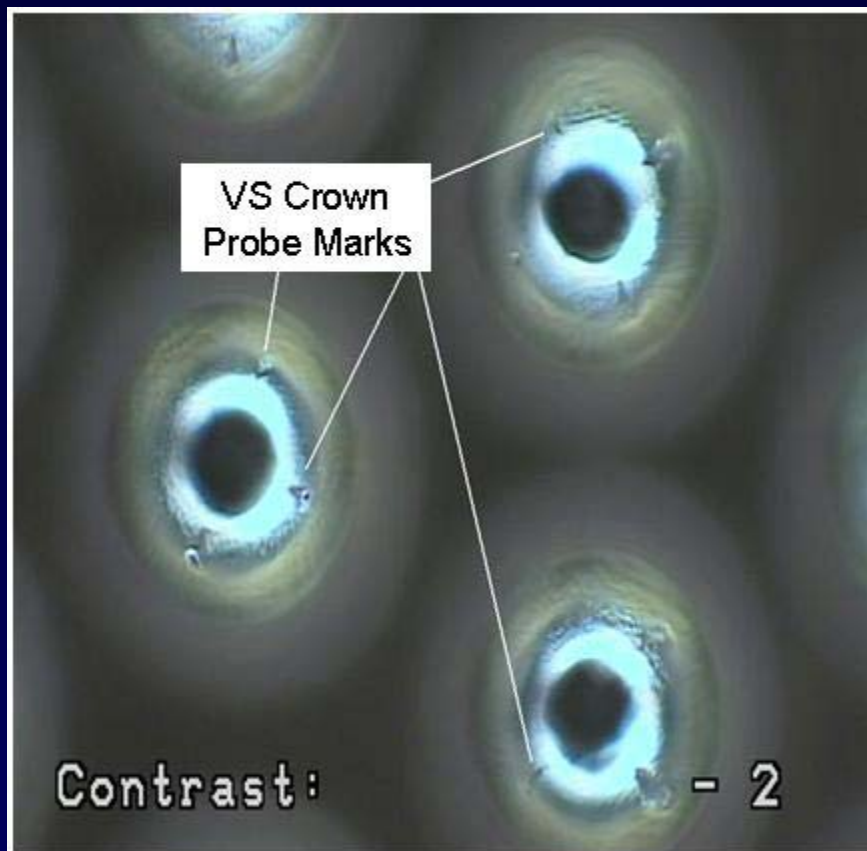
VS Crown Tip Probe Mark Images



VS Crown Tip Probe Mark Images

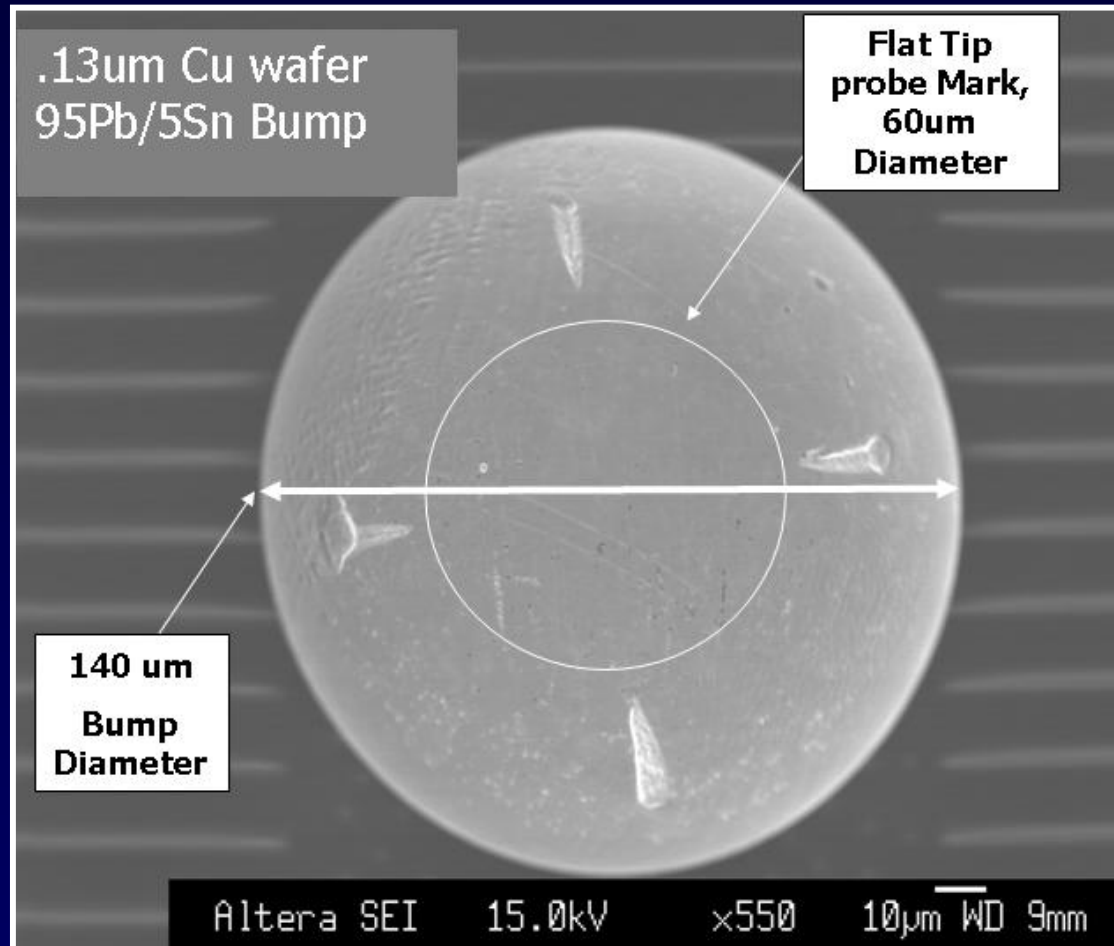


Microscope Images of VS Crown Tip Probe Marks

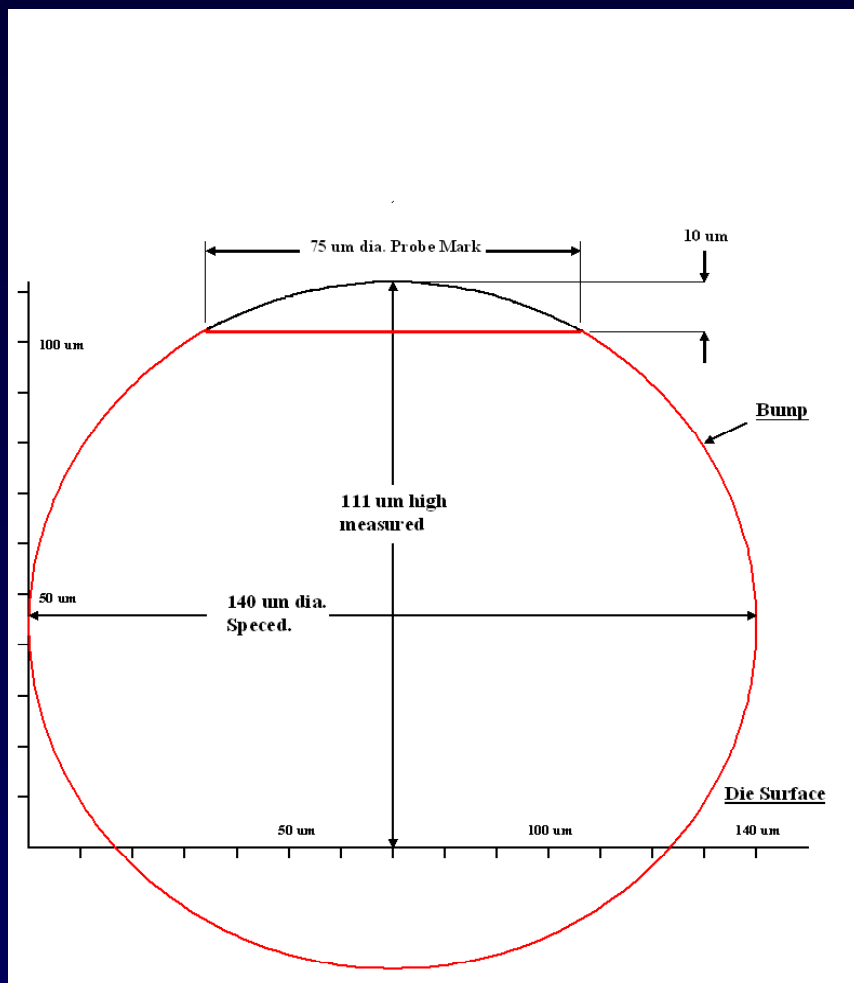


Probe Mark Size Comparison

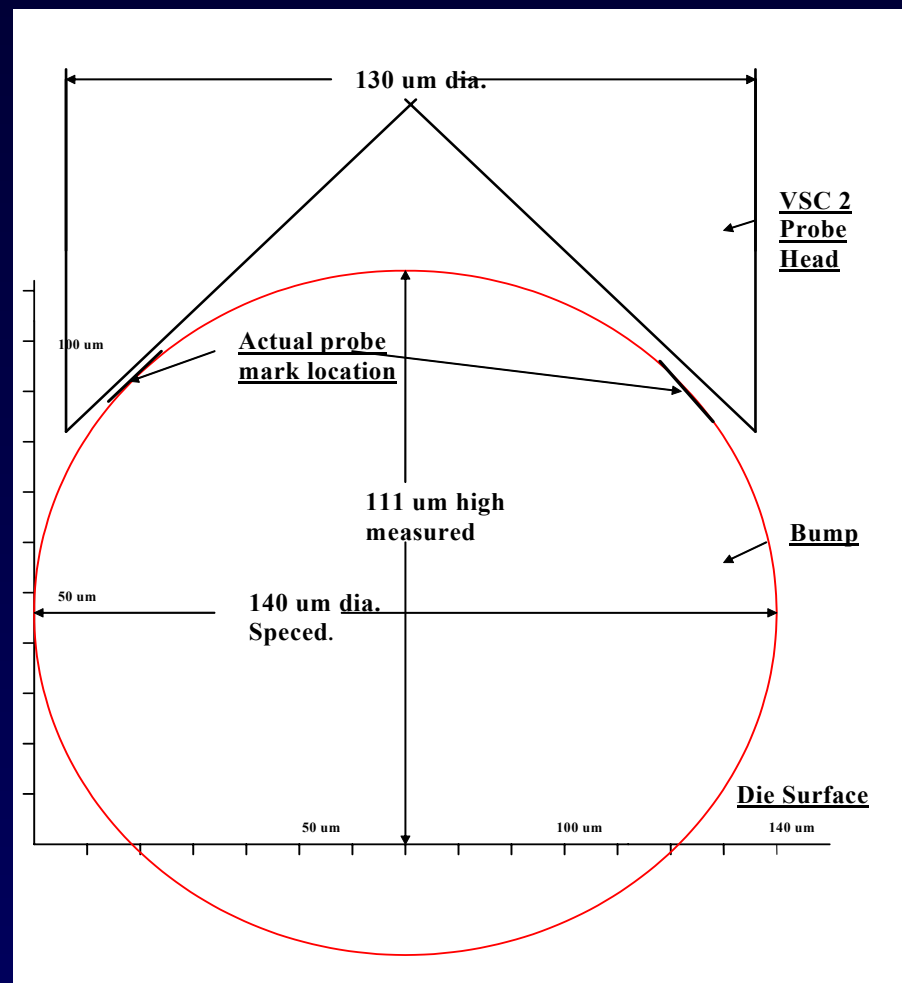
- Crown Tip Marks vs. Flat Tip Bump Deformation



Side View Comparison Of Probe Marks

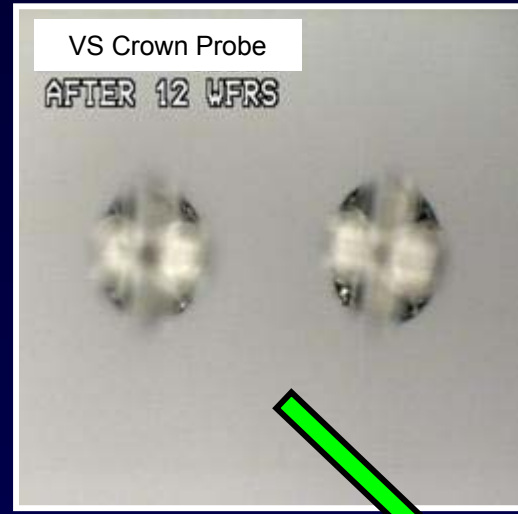
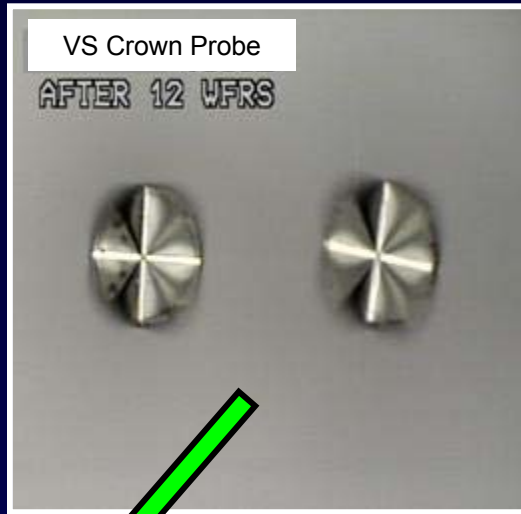


Flat Tip



Crown Tip

VS Crown Probe After Sorting 12 Wafers



Non-destructive on-line cleaning is needed to keep the contact surfaces debris free.

Path Resistance Measurement

- Shorted Probe Card PCB used to zero out the resistance measurements of Test Head and Test Head Cables.
- VS crown tip probe card used to probe a shorted wafer, using 150 μm OD.
- Resistance measurements taken at 3 minute intervals, while resting on a die, no Z-up or Z-down in between.
- Zero out resistance measurements subtracted out to acquire actual path resistance.

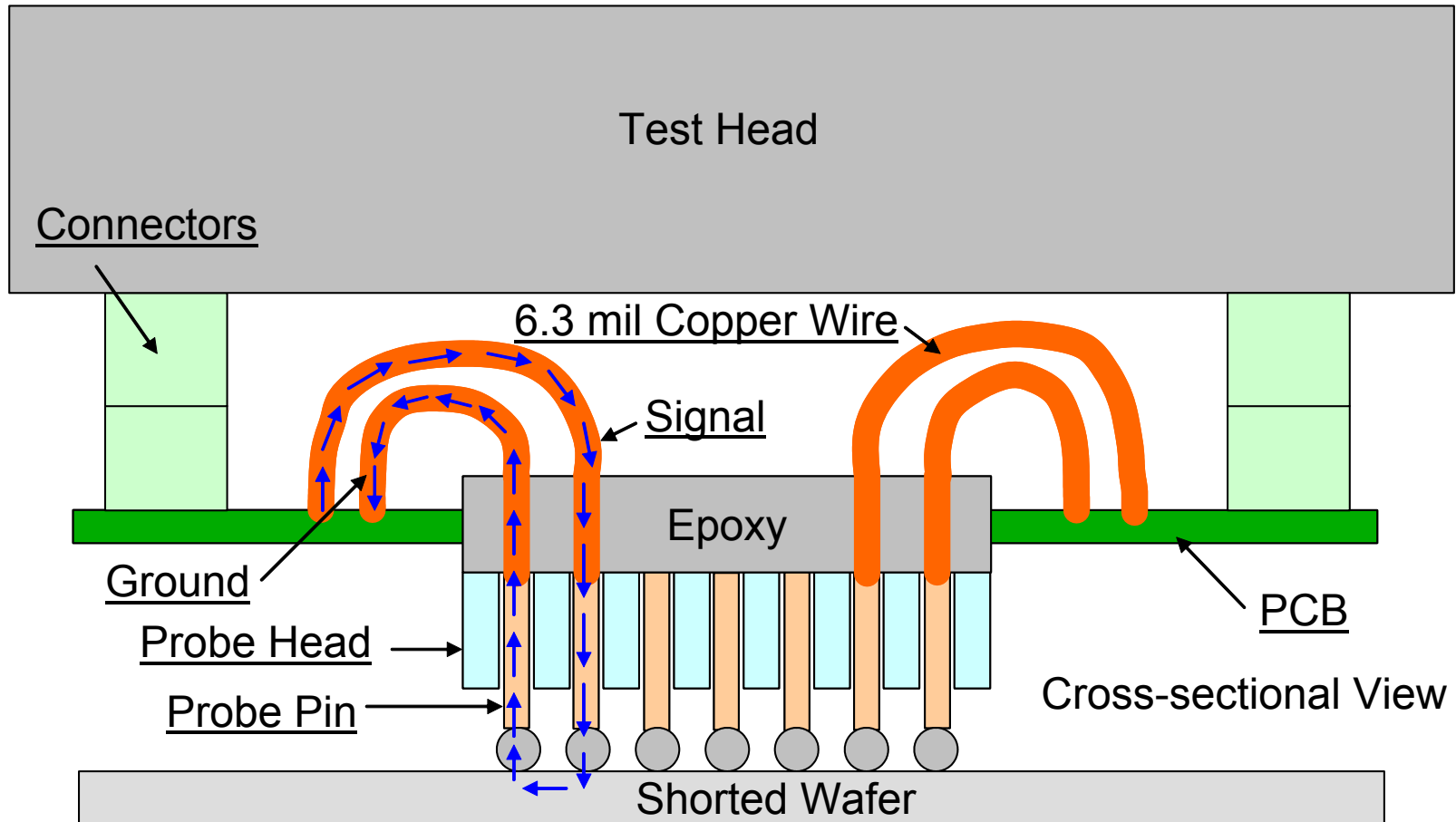
Yield Comparison

- Use VS flat tip and VS crown tip to probe the same wafers.
- Perform selective resort (resorting bad dice only) with both technologies to achieve maximum yield for comparison.
- Inspect VS crown tip probe marks.
- Inspect VS crown tip probes to compare bump residue build-up.
- Measure Planarity and Contact Resistance using PRVX.

Testing Parameters

- Same tester and prober used throughout the experiments.
- VS Flat Tip parameters
 - Probing: 175um OD
 - Cleaning: 50um OD, 12 times every 50 dice
 - Cleaning medium – 3M 1um lapping film
- VS Crown Tip parameters
 - Probing: 150um OD
 - Cleaning: 100um OD, once every wafer
 - Cleaning medium – Probe Polish 99, filled cleaning polymer
 - Due to tip shape requirements a lapping film cannot be used

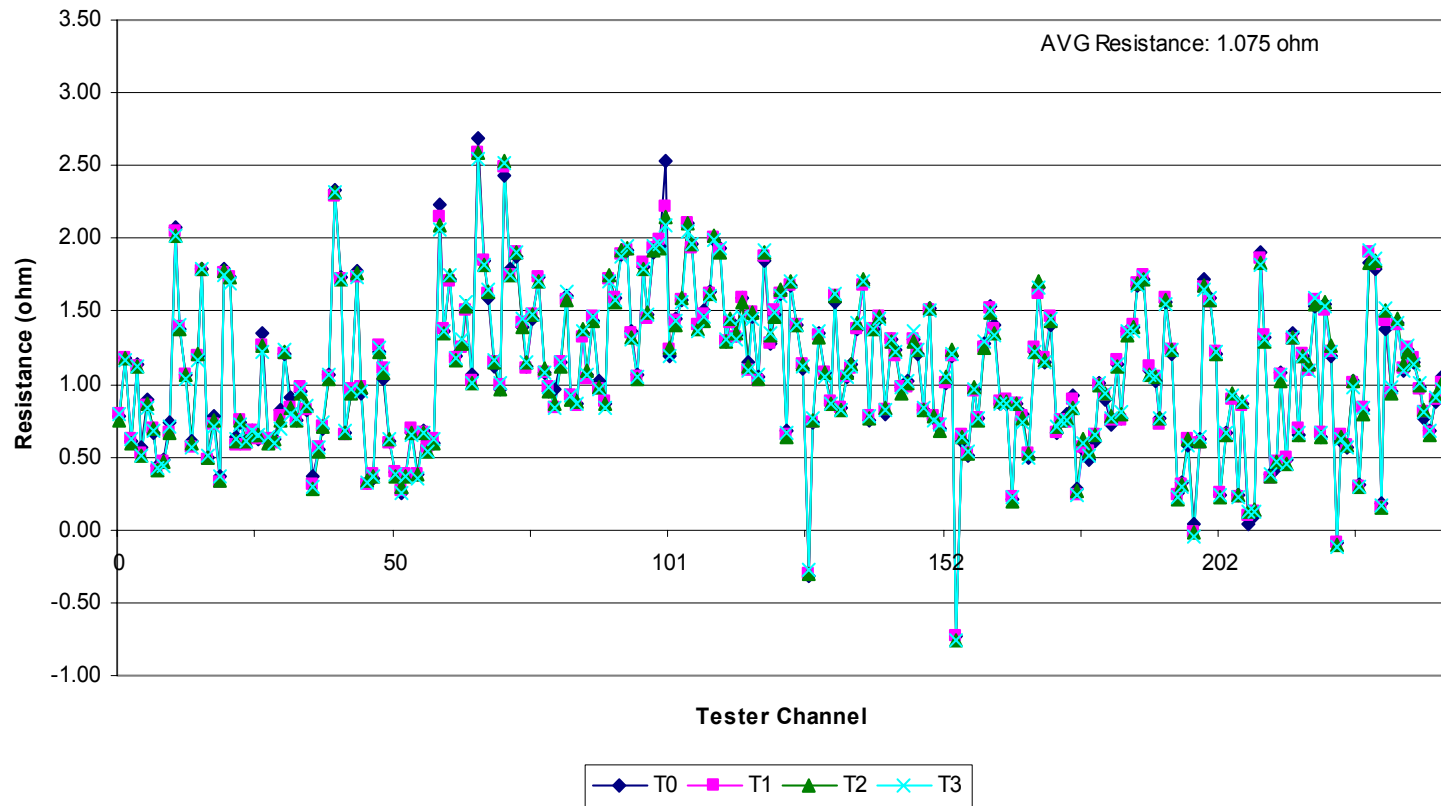
Physical Path Measured for Resistance



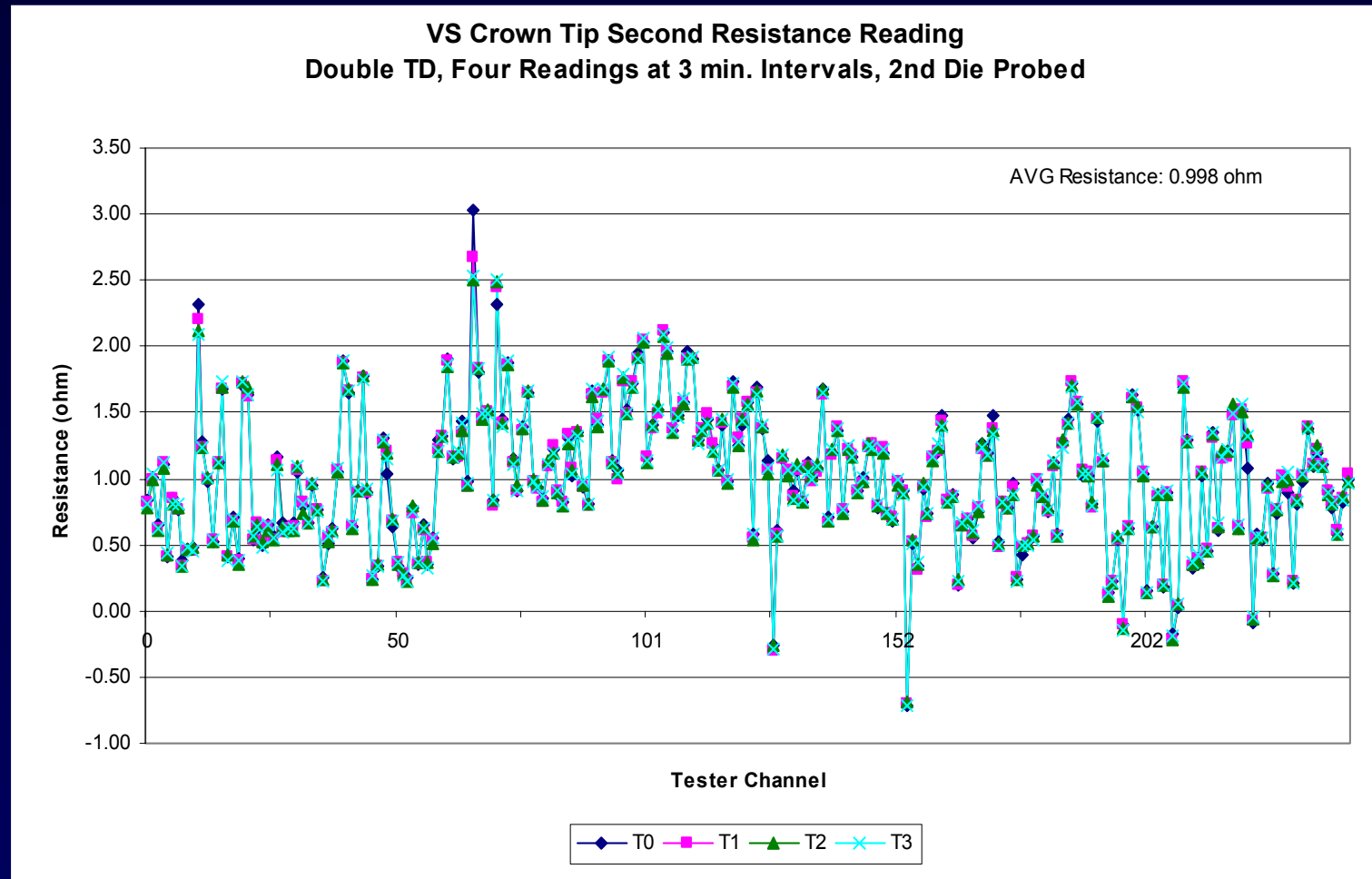
Path Resistance measured outlined by Blue Arrows.

Path Resistance, 1st Die Probed

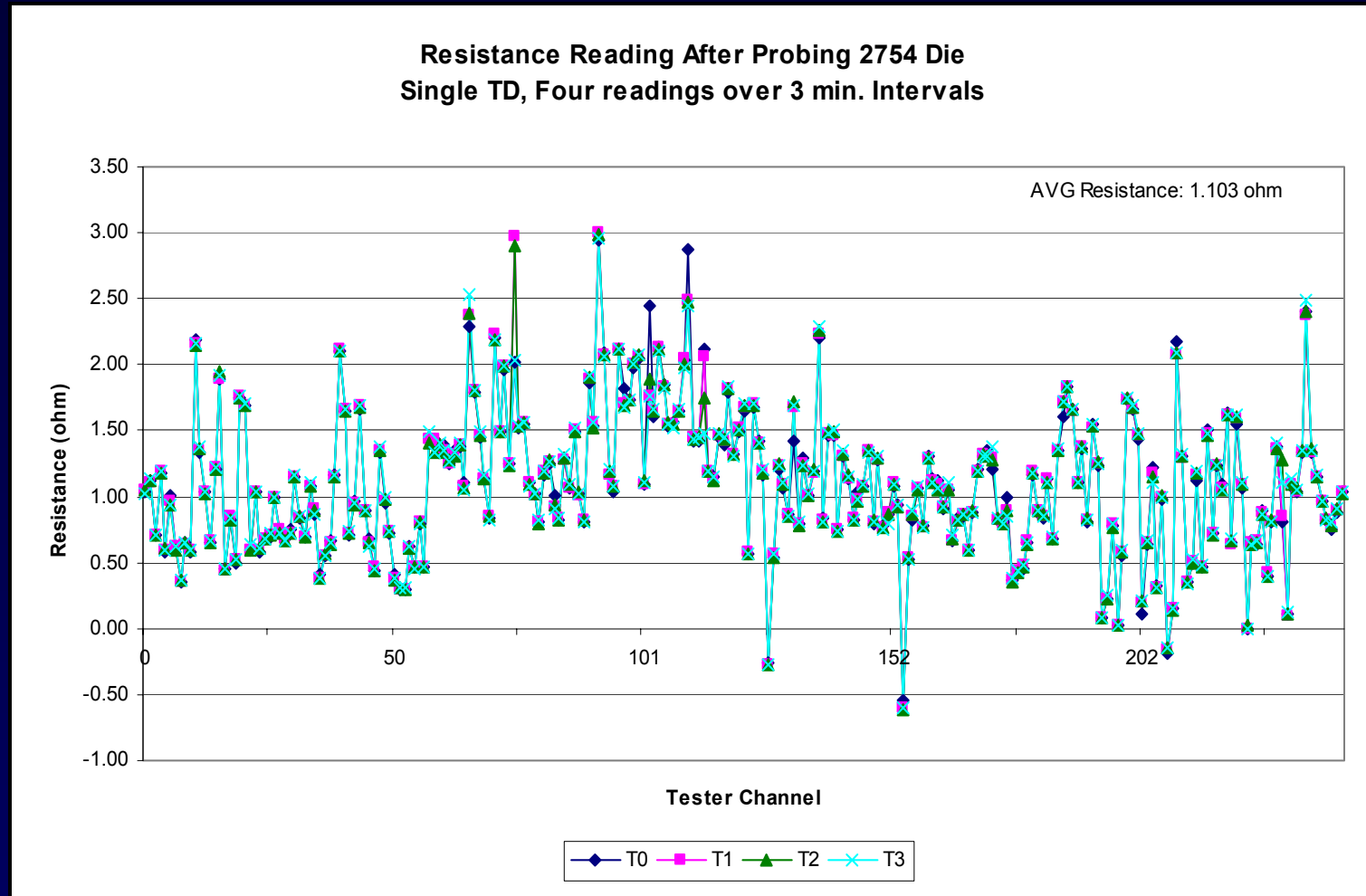
VS Crown Tip Second Resistance Reading
Single TD, Four Readings over 3 min. intervals, 1st Die Probed



Path Resistance, 2nd Die Probed

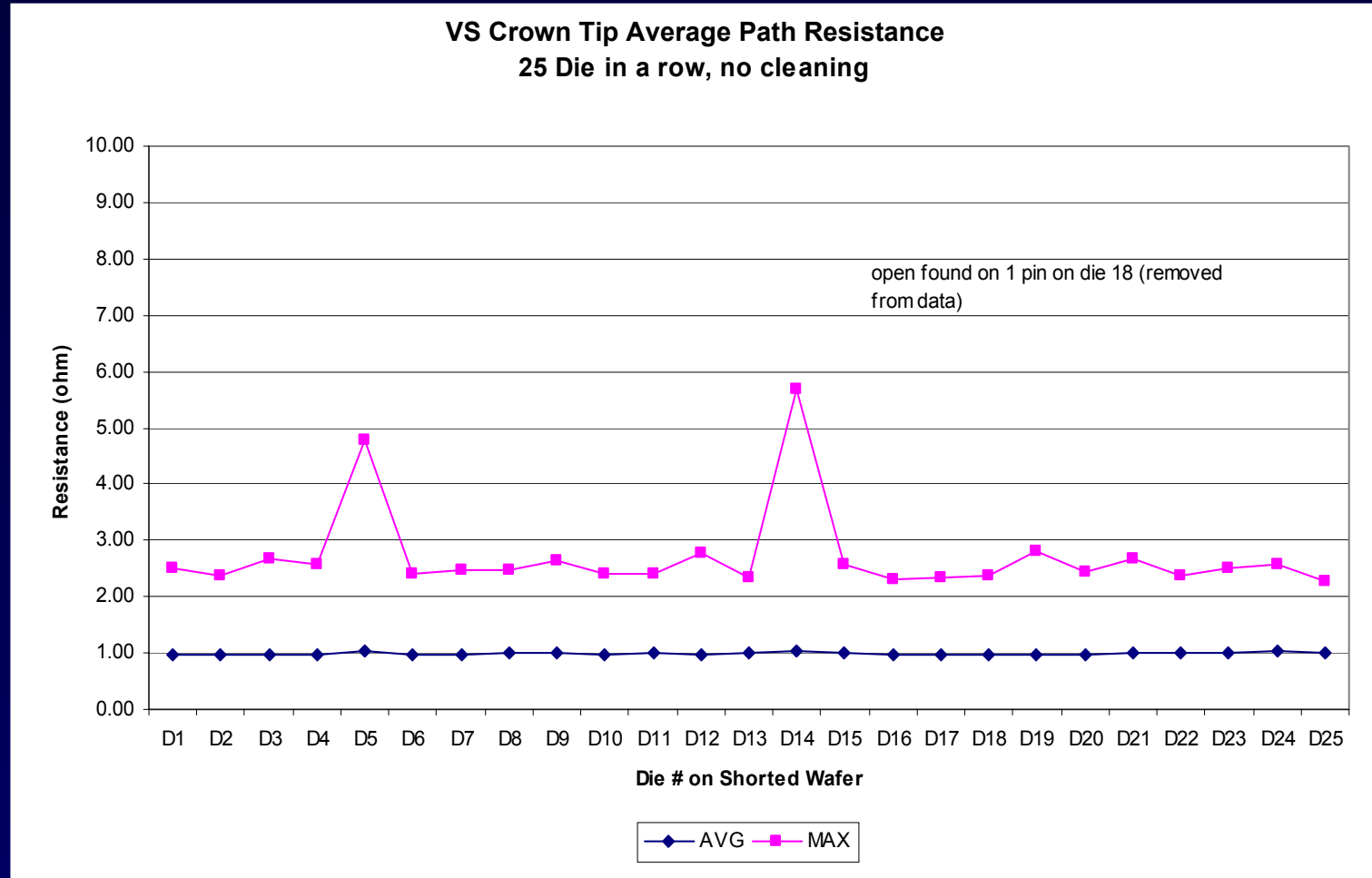


Path Resistance, 2754th Die Probed



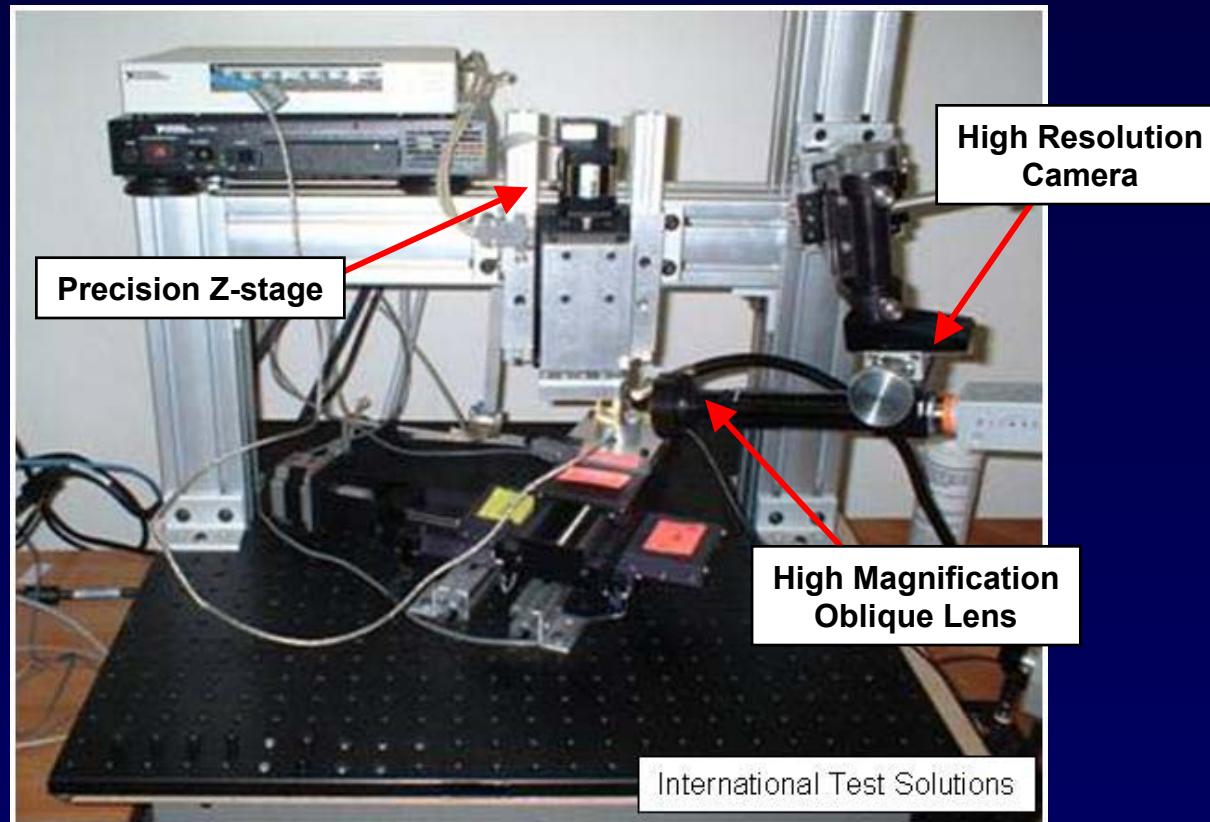
Average Path Resistance

- 25 Die Tested in a row, with no Cleaning



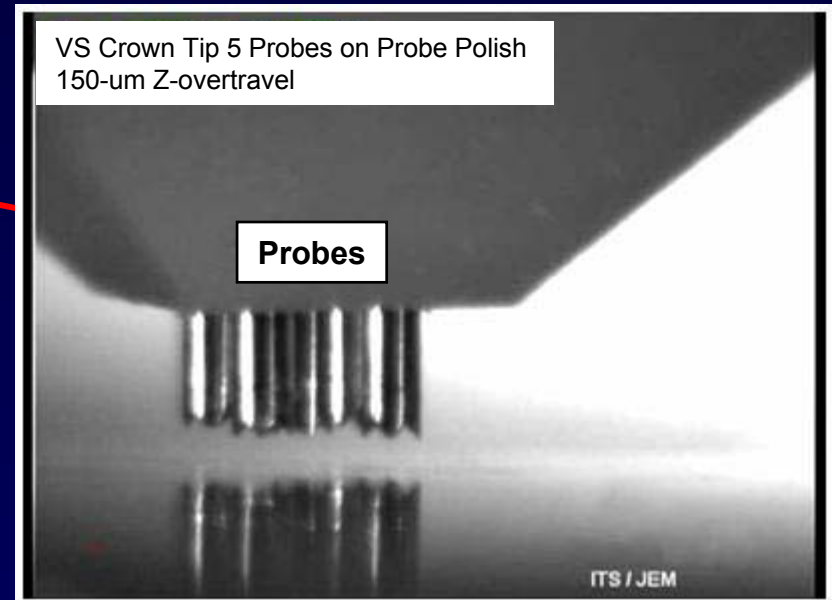
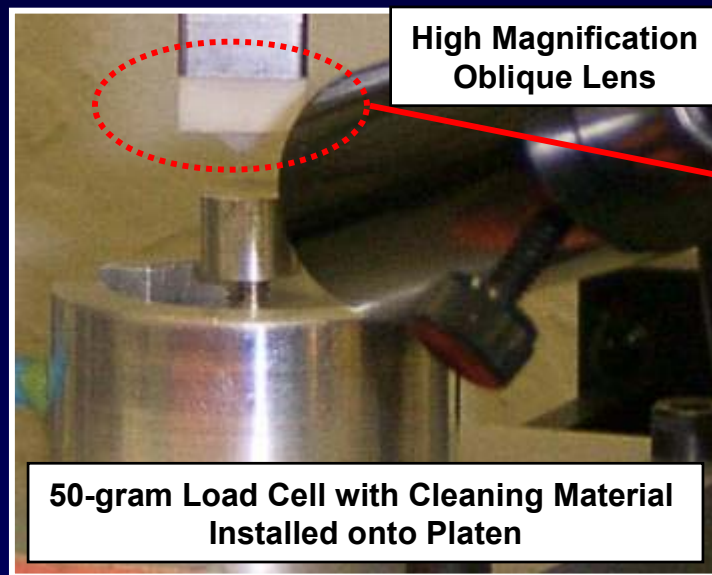
Mechanical Performance Characterization

- Bench-top Materials Testing System
 - Assess cleaning material performance.
 - Evaluate applied load characteristics of probe.



Mechanical Performance Characterization

- High resolution and video imaging
- Synchronized load vs. overtravel data acquisition



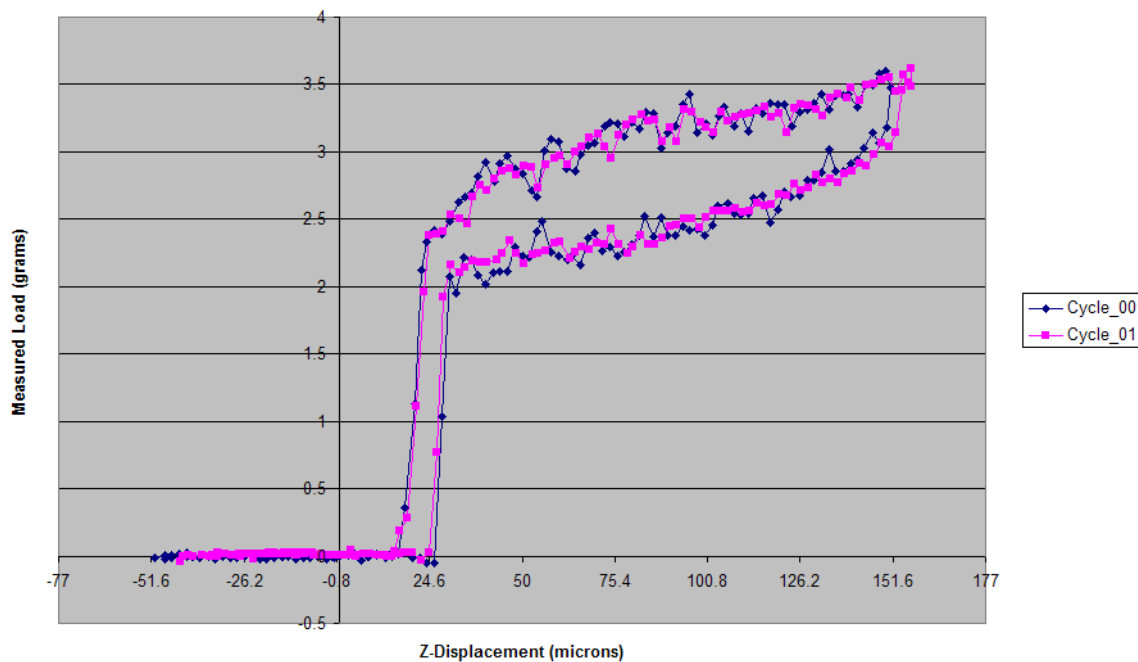
High Magnification and High Resolution Imaging

Probe Contact with Bump

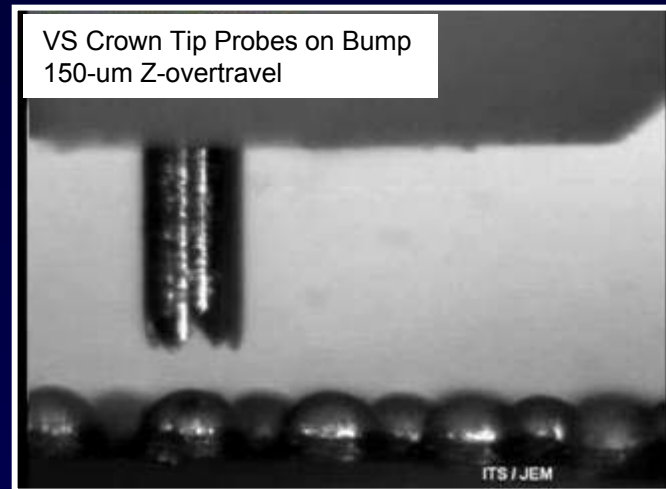
Play Video



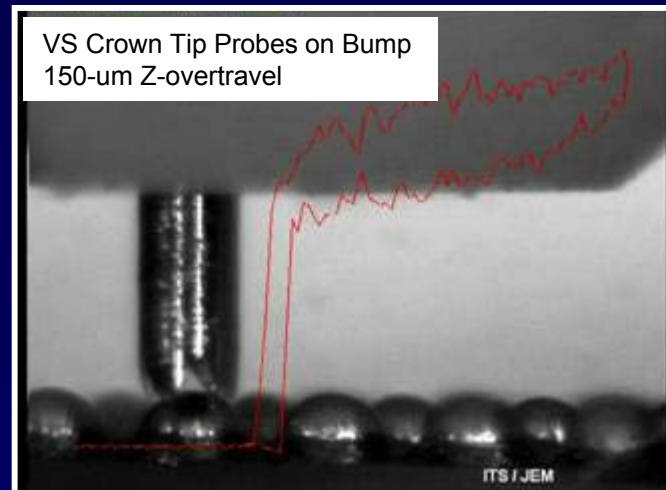
1 x VS Crown Tip Probe at 150um OT
on Solder Bump Material



VS Crown Tip Probes on Bump
150-um Z-overtravel



VS Crown Tip Probes on Bump
150-um Z-overtravel

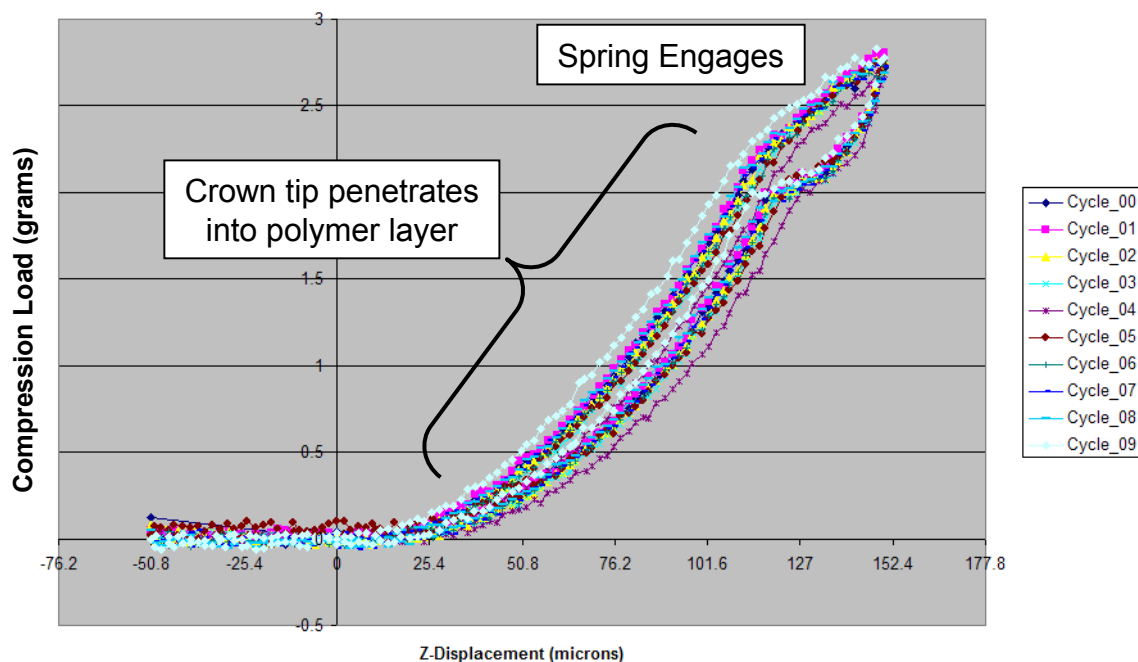


Probe Clean to Visualize Penetration

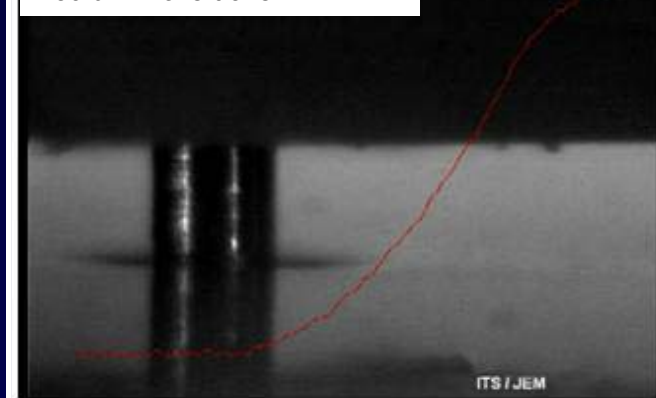
Play Video



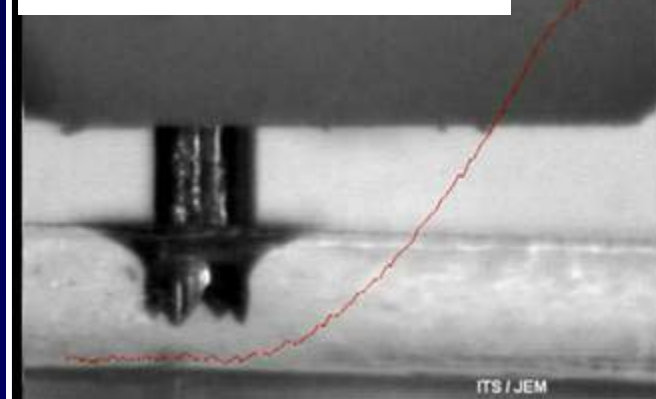
1 x VS Crown Tip Probe at 150um OT
on Probe Clean Material



VS Crown Tip Probe Cleaning
150-um Z-overtravel



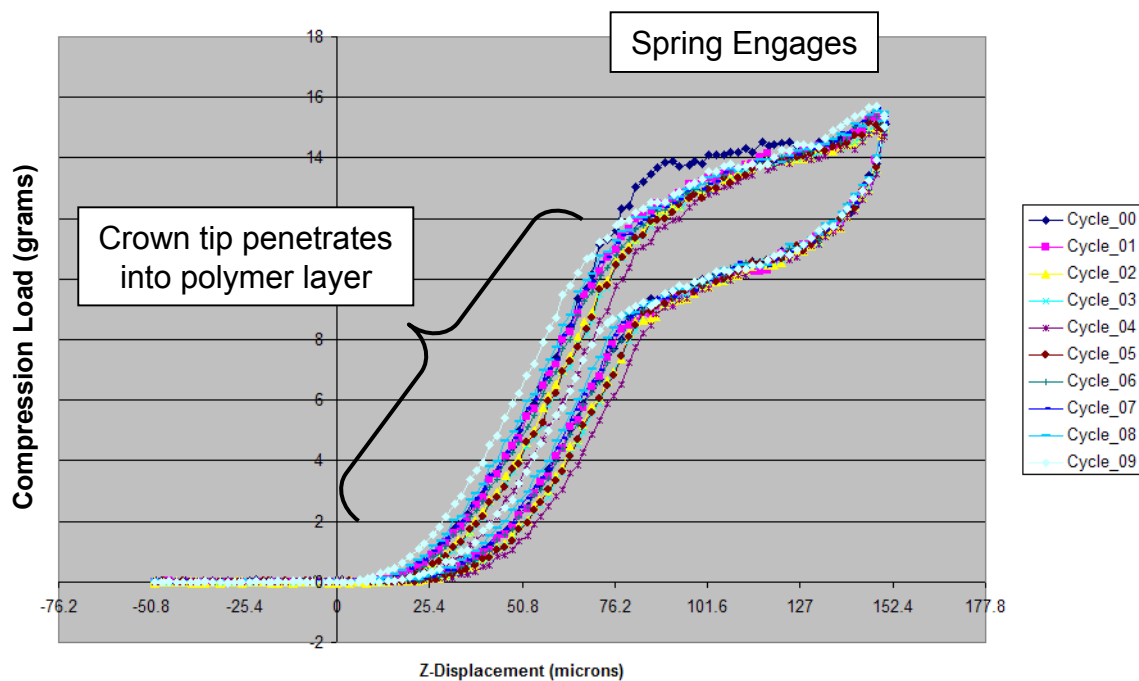
VS Crown Tip Probes on Probe Clean
150-um Z-overtravel



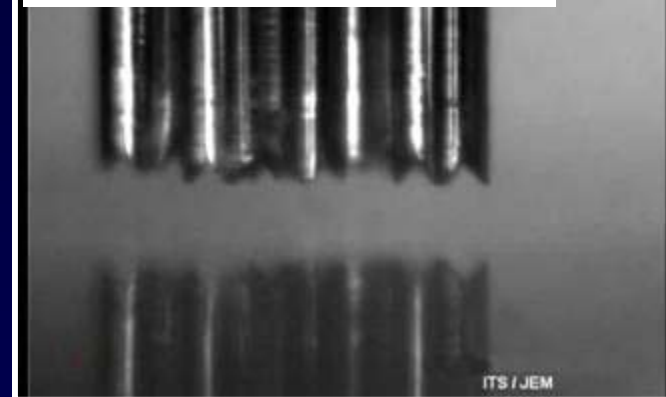
5 Probes on Probe Polish 99

Play Video 

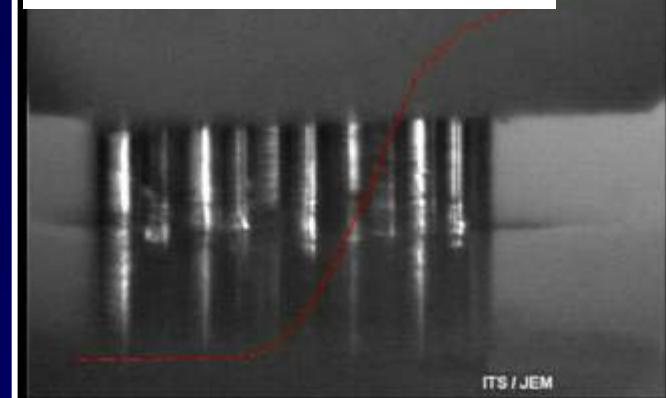
5 x VS Crown Tip Probe at 150um OT
on Probe Polish Material



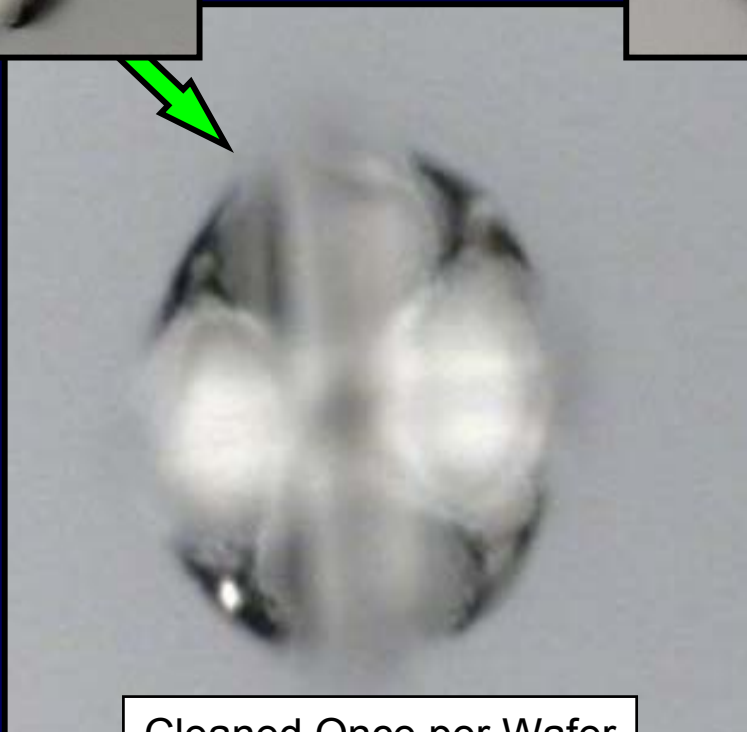
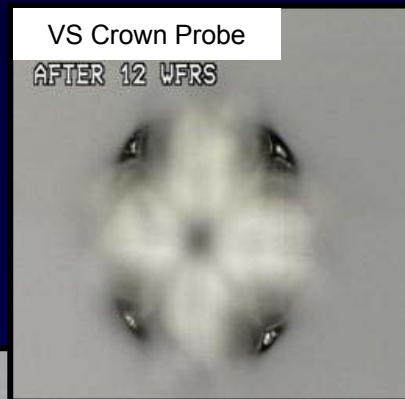
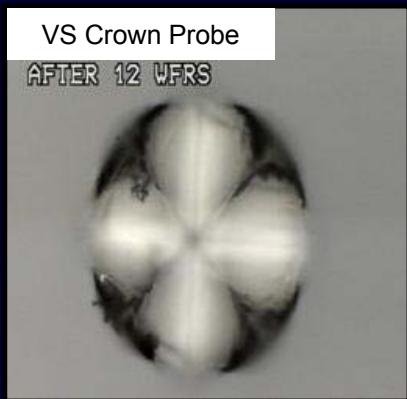
VS Crown Tip Probes on Probe Polish 99
150-um Z-overtravel



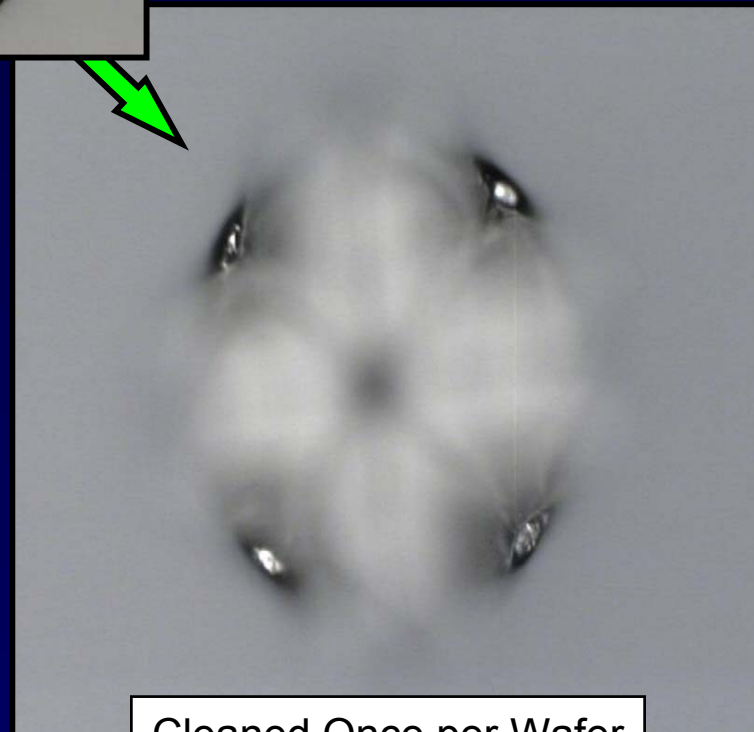
VS Crown Tip Probes on Probe Polish 99
150-um Z-overtravel



VS Crown Tip Probes After Online Cleaning



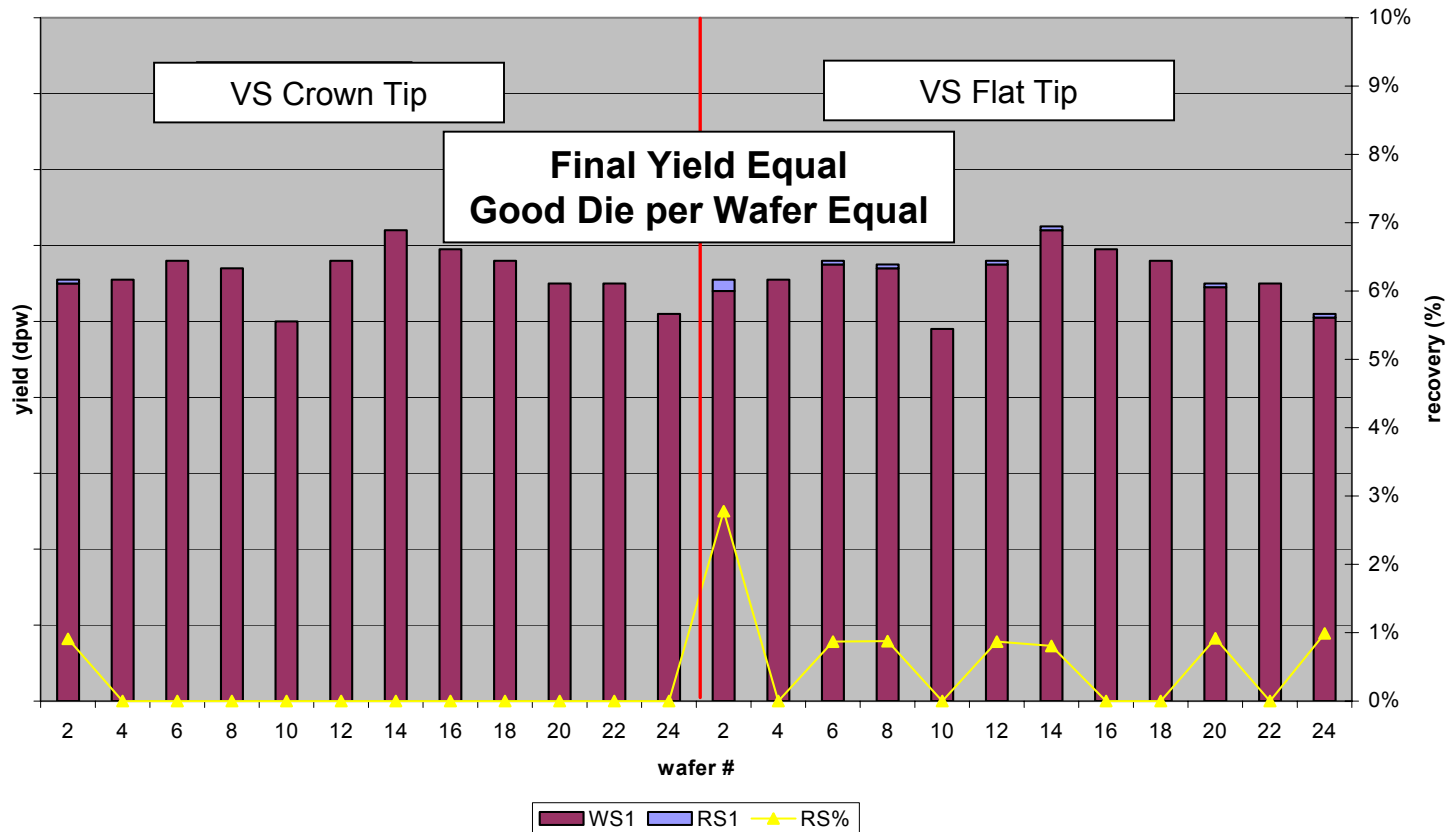
Cleaned Once per Wafer



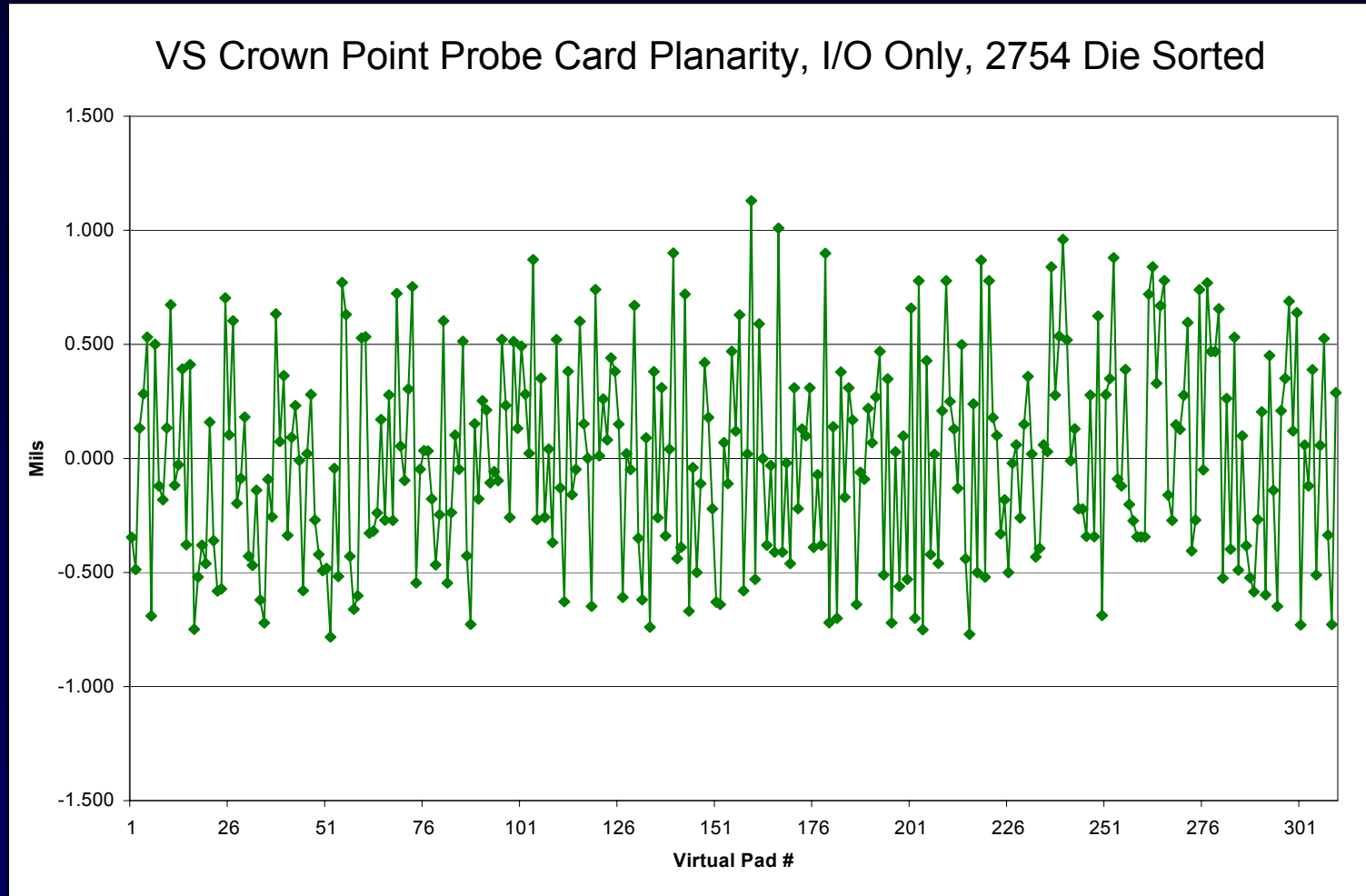
Cleaned Once per Wafer

Yield Comparison

VS Crown Tip vs. VS Flat Tip

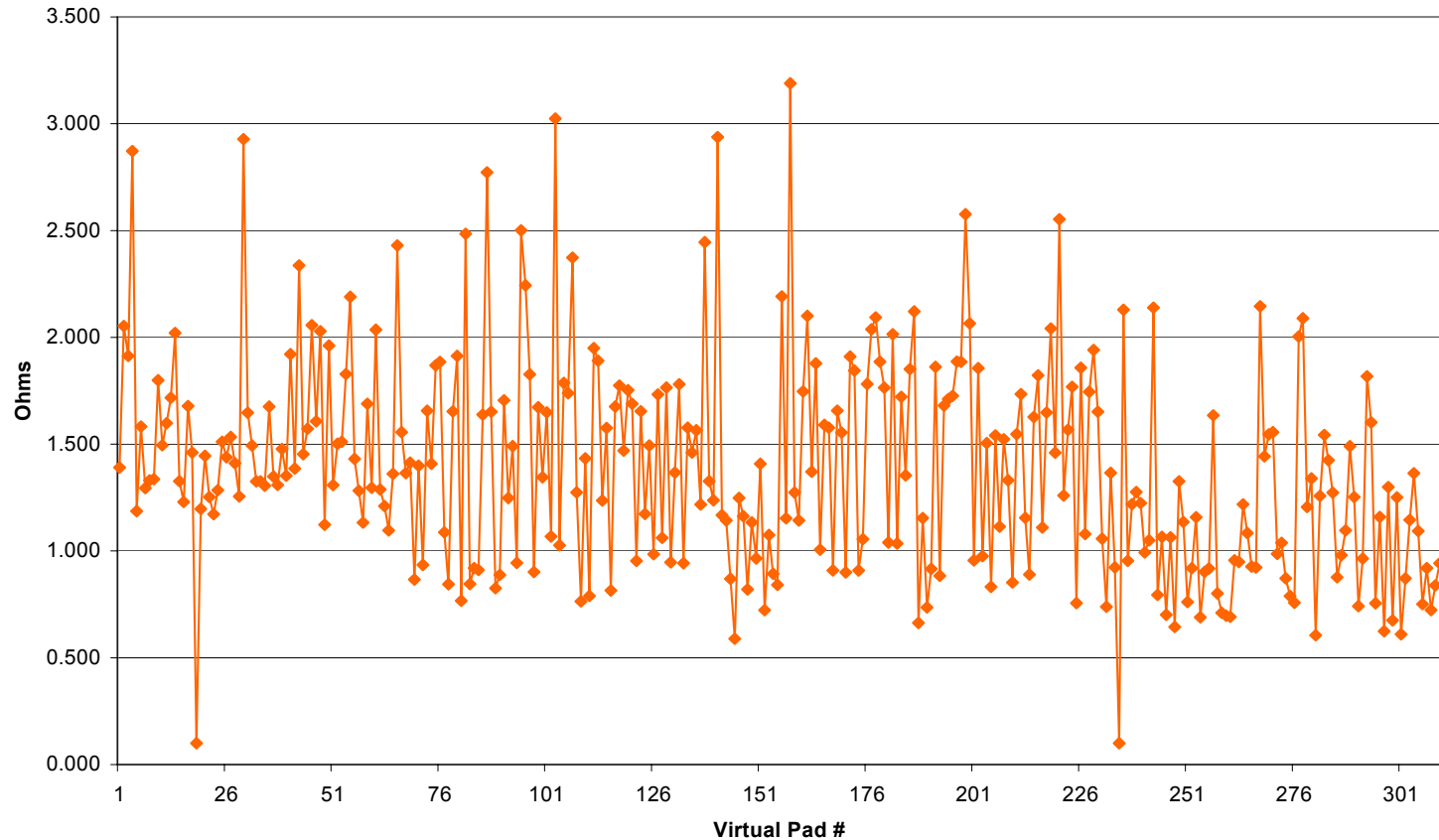


Planarity Reading from PRVX



Contact Resistance Reading from PRVX

VS Crown Point Probe Card Contact Resistance, I/O Only, 2754 Die Sorted



Summary

- VS crown tip probe path resistance is on the same order as standard VS flat.
- VS crown tip Path Resistance holds stable after 2500+ die sorted and non-destructive cleaning only after each wafer.
- VS crown tip is able to achieve maximum yield at first sort, with lower resort recovery.
- Probe marks generated by VS crown tip show minimal disturbance to the bump structure, compared to VS flat tip and other vertical probing technologies.
- On-line cleaning with Probe Polish 99 was effective in keeping the crown tip clean without affecting the tip geometry in order to maintain consistent yield.
- Planarity remained at +/-1mil after probing 12 wafers.

Acknowledgements

- Patrick Mui – Engineering Manager, JEM-America
- Altera Manufacturing Engineering
- JEM-Japan Test Engineering
- ITS Applications Engineering

Thank you for your attention

Questions ???