IEEE SW Test Workshop
Semiconductor Wafer Test Workshop

Anil Kaza
Intel Corporation

Metrology and Probe Repair challenges with tighter pitch probe cards

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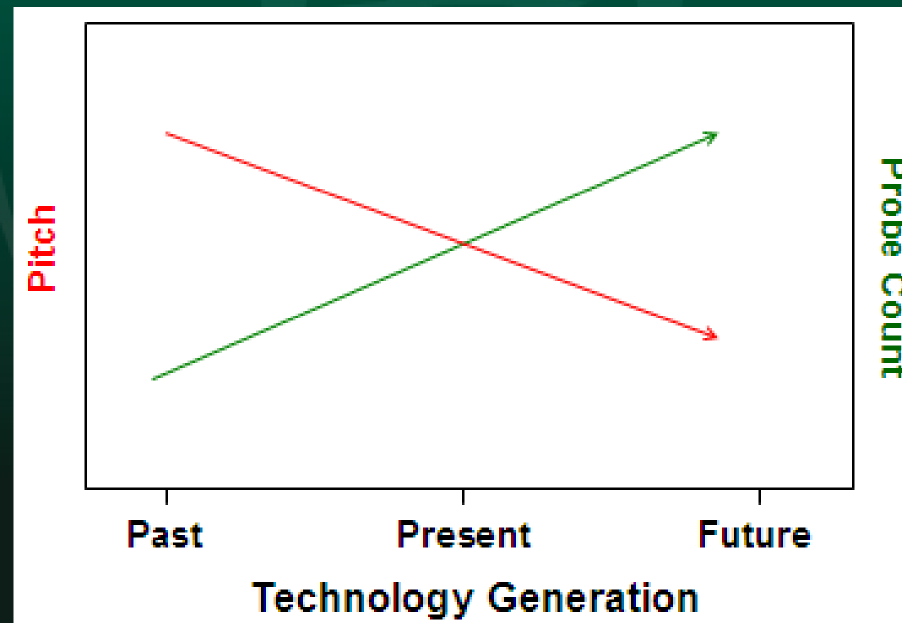
Overview

- **Current trends with technology generation**
- **Intel PCM**
  - Work Flow
  - How it is different
- **Probe card metrology challenges**
- **Probe repair challenges**
- **Industry Collaboration**
- **Summary**

Pitch and Probe Count

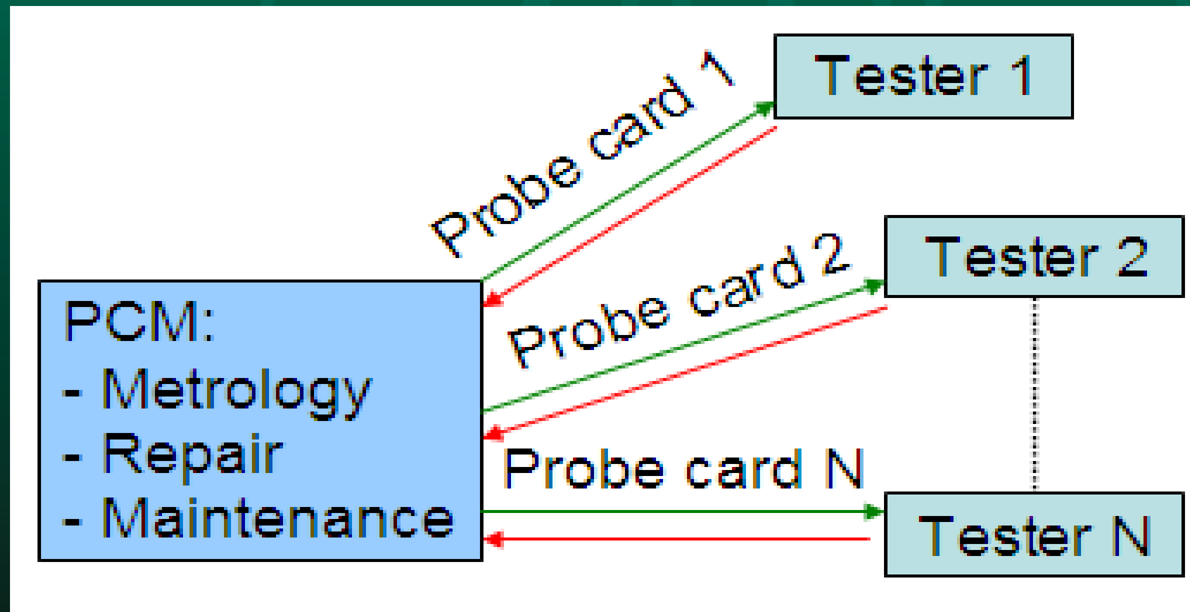
- **Pitch continues to shrink and probe count continues to increase with each generation**
  - Probe Count ↑ due to parallelism and product requirements
  - Trend continues in foreseeable future



- **Metrology, repair and maintenance challenges**

Intel PCM

- **Unique and unlike any other sort floor**
  - Several probe cards and multiple testers



- **PCM activities critical to running of sort floor**
  - New challenges need to be addressed ahead of time
  - Impact to SIU availability, product sorting

Metrology Test Development

Optical Algorithm is the most challenging

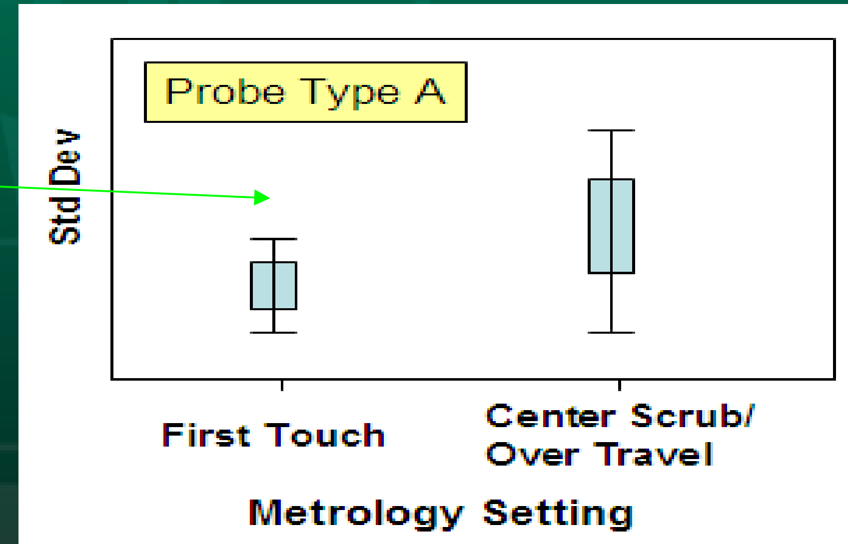
- Needs to work on new/different probe technologies
  - Probe types, materials, surface finish, shapes and sizes
- Ability to recognize and distinguish probes at tighter and tighter pitches
- Repeatable and Robust throughout lifetime
  - Meet repeatability and reproducibility criteria
- Ability to measure Z ht of features on probe tips
- Efficiency and throughput
  - Probe count increases

Optical Data Analysis

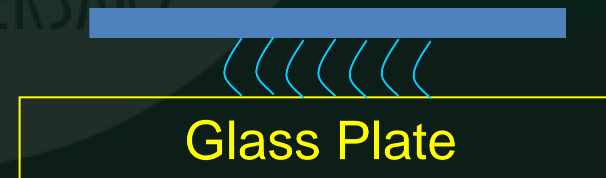
Different probe types need different settings for best optical metrology results

Data for probe type A (vertical type) indicates less variation with “First Touch” setting

Probe type B gives more meaningful data with “Center Scrub” or “Over Travel” setting



Current optical test process has 2 passes/scans always



Glass Plate

Glass Plate

No OT/Free Hanging position

OT position

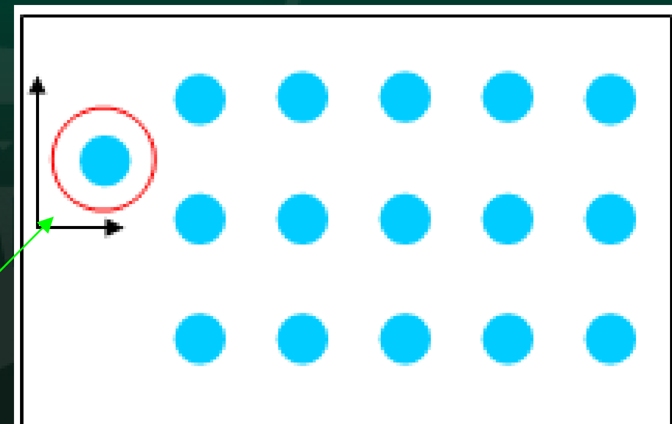
Metrology Improvements

- **Optical test routine needs to be configurable**
  - Currently it is always 2 pass routine
  - Option for either ONE pass only or 2 passes depending on probe type
    - Software/Hardware changes
- **Prefer standard optical algorithms in industry working on different probe types**
- **Test throughput is also important**
  - Increasing probe counts and tighter pitches

Probe Card Repair Challenges

Probe Repair and Maintenance

- **More and more difficult with tighter pitches and increasing probe counts**
- **New difficult layouts not helping either**
- **Impact of probe repair challenge**
  - Significantly affects SIU availability
  - Repair process throughput
  - Increased overall sort cost
  - Affects product sorting
  - Ergonomic considerations



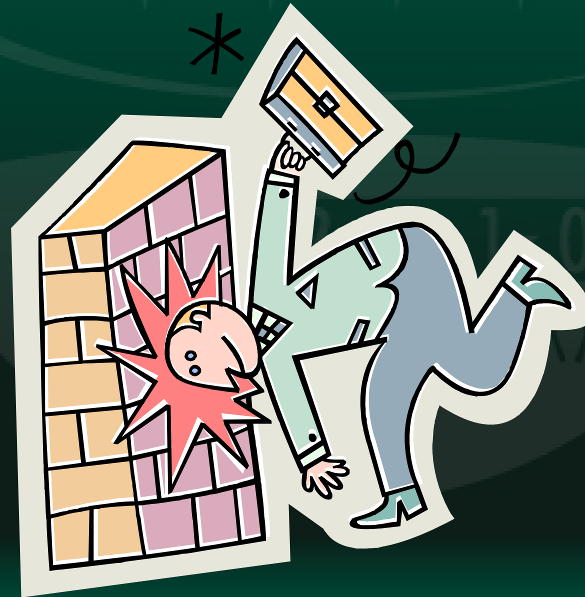
No reference points/probes to adjust this probe in X or Y direction

Current Status

- **Adjustment performed manually**
- **Procedure**
  - Run optical test on metrology tool
  - Adjust probes under microscope
  - Use adjacent probes as reference for adjustment
  - Run optical test again to verify adjustment
  - Go back and forth between metrology and probe adjustment (multiple times)-tedious process
    - Metrology tool not used for adjustment because of ergonomic concerns
      - No height adjustable stage for different operators

Going Forward

- Hit a brick-wall with current procedure, set-up and tools
- Almost impossible to repair next generation tighter pitch probes efficiently



Problem Resolution

- **Radical change in current procedure needed to break the brick-wall**
  - Tools/apparatus
  - Procedures

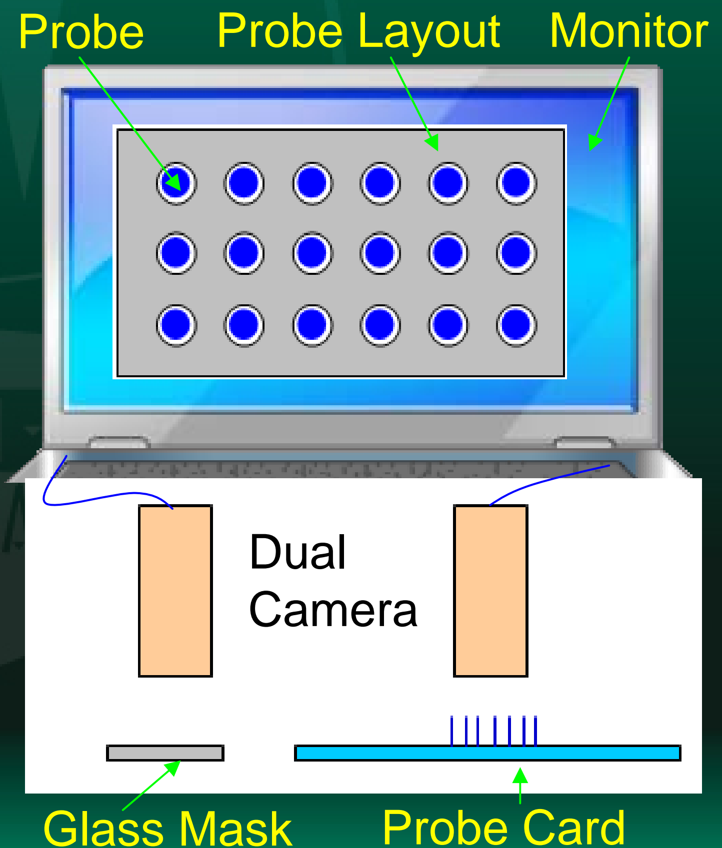
- **Currently attacking the different aspects of the problem**
  - Still in early development and proof of concept

Problem Solution/Future Vision

- **Improvement/Changes in different areas**
  - Real time verification of probe adjustment
    - Helps in throughput
    - Good qualitative assessment before metrology
    - ➢ **Overlay**
  - Semi-automated process for adjusting probes
    - Important as pitch ↓ and probe count ↑
    - ➢ **Micro-manipulators**
    - Micro-tools/tweezers for interacting with probes
      - Different shapes depending on the purpose

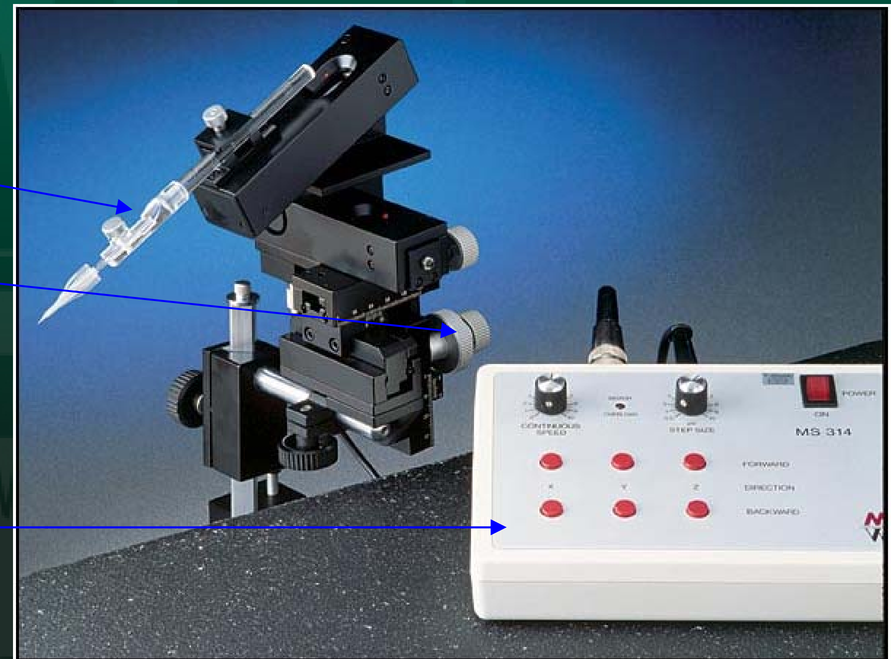
Overlay

- **Super impose the probe array and the layout**
  - Use a monitor display for overlay
- **Real time feedback for probe repair**
- **2 options explored**
  - Dual camera with glass mask
    - Glass mask under 1 camera
    - Overlay on the monitor
    - Proof of concept works
  - Digital electronic overlay
    - No need for multiple glass mask maintenance
    - Challenge with image sync movement (X and Y) and zoom



Micromanipulator

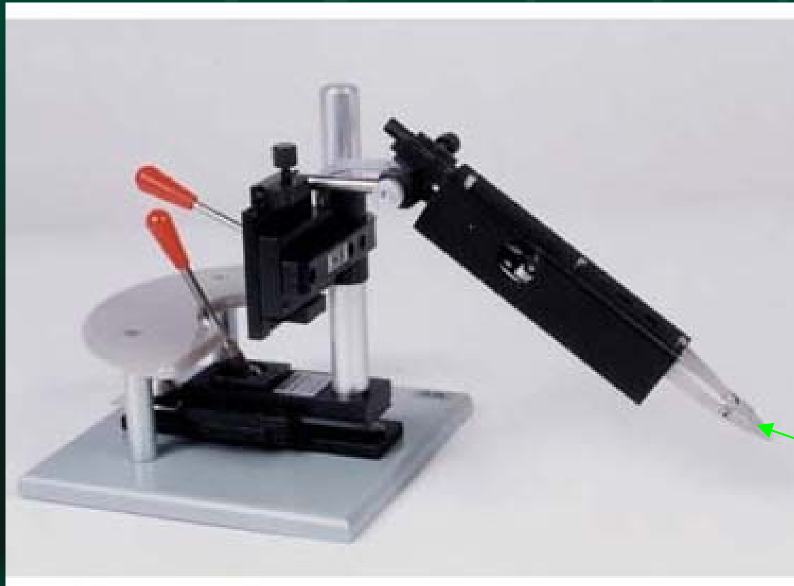
- **Example of a motorized micromanipulator**
- **Attach different end (needle) shapes**
- **Desired Features**
  - Mechanical pencil holder
  - Manual movements
  - Control Box
  - Micron level movement in X, Y and Z



Picture taken from Warner Instruments

Micro-tweezers

- **Micro-gripper example**
  - Ability to grab a probe
  - Control box for fine adjustments
- **Most challenging task**



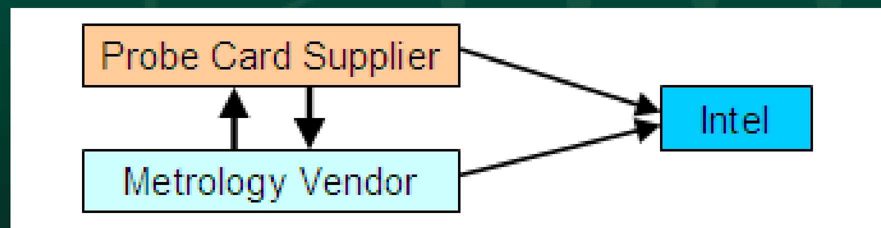
Picture taken from Warner Instruments

- Can control the opening and separation between the tweezer ends
- Getting the right grip and angle is critical

Tweezers shaped ends

Industry Collaboration

- **Integration of new probe card supplier or metrology vendor needs to be smooth**
  - Prefer suppliers/vendors to engage proactively
  - Metrology challenges need to be addressed ahead of implementation at Intel



- **Next generation probe repair station**
  - Functionality, throughput and ergonomics
- **Call out to industry for other repair ideas**
- **Interaction with industry to develop and make the probe repair station happen (at Intel)**

Summary

- **Challenges need to be addressed due to continuous pitch reduction and increasing probe count**
  - Metrology
  - Probe repair and maintenance
    - Development work started with proof of concept demos for repair station
- **Need industry collaboration for solutions and possible new ideas**

Q & A