IEEE SW Test Workshop
Semiconductor Wafer Test Workshop

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Benefits of Flip Chip Wafer Sort using MEMs Multi Site Capability

Lessons learnt

GLOBALFOUNDRIES

FORMFACTOR®

June 6 to 9, 2010 San Diego, CA, USA

Outline

- **The Growing SOC Market**
- **Test Vehicle and Test Parameters**
  – Chuck Force Comparison
  – Probe Mark Comparison
- **Cleaning Considerations**
- **Yield Comparison**
- **Electrical Properties Comparison**
- **Test Performance**
- **Summary**

GLOBALFOUNDRIES – Who Are We?

Global Manufacturing Operations

Fab 8
Future leading-edge 300mm manufacturing
Saratoga County, NY

Fab 1
Leading-edge 300mm manufacturing campus
Dresden, Germany

Fab 2, 3, 3e, 5, 6
Mainstream 200mm manufacturing campus
Woodlands, Singapore
Tampines, Singapore

Fab 7
Mainstream 300mm manufacturing campus
Woodlands, Singapore

Motivation for Vertical / MEMs Technology

Flip Chip Market Trend

2000
1800
1600
1400
1200
1000
800
600
400
200
0

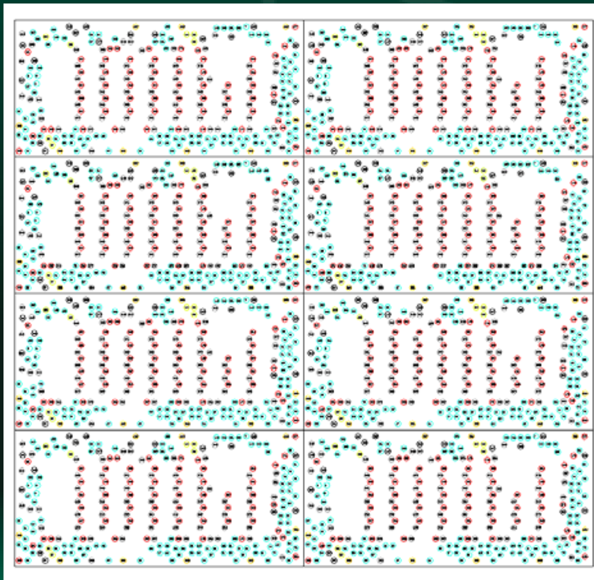
2007 2008 2009 2010 2011 2012

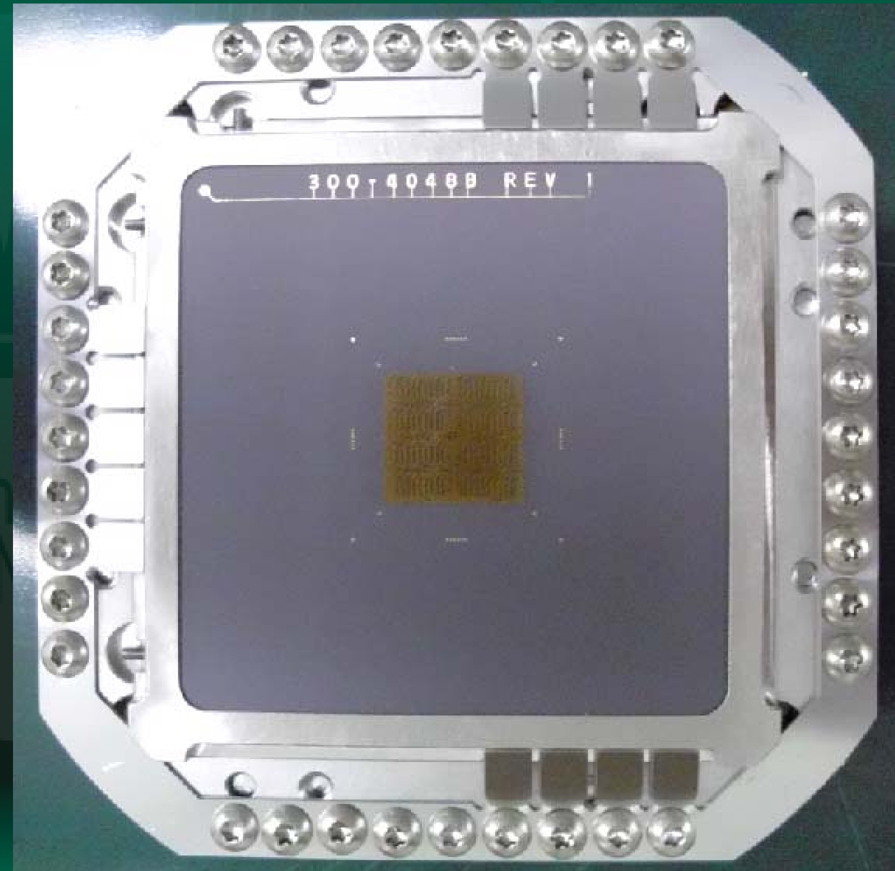
- HDTV/SetTop
- Chipsets
- Graphics
- ASIC/DSP
- Games
- CPUs

Source : TechSearch International Inc.

Test Vehicle Information

- **Application: Universal Mobile Telecommunication Chip**
- **Technology Node: 65nm**
- **Die Size: 3.4mm x 7.1mm**
- **Pitch: 180um**
- **Bump Material: Eutectic**
- **Probe Count per Die: 278**
- **Multi-Site: 2 x 4 Solid Array**





Probe-card Chuck Force Comparison

- Significant increase in chuck force needed for Vertical probe with higher pin count

Total Chuck force Comparison

Test Vehicle 2224 probes

Test Vehicle 4448 probes

Gram Force (in kg)

0 10 20 30

0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000 3200 3400 3600 3800 4000 4200 4400 4600 4800 5000

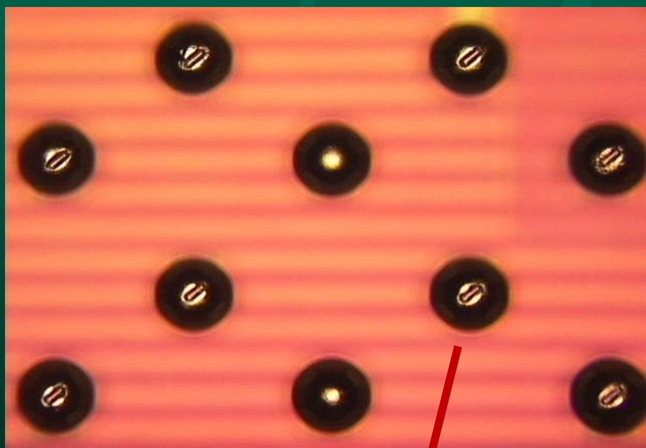
# of pins

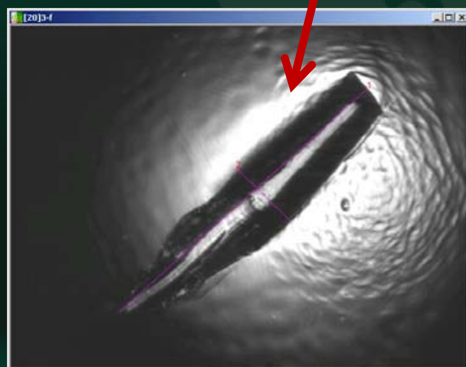
MEMS (SR=1) Cobra Type

Probe Mark Comparison (MEMS vs Vertical)

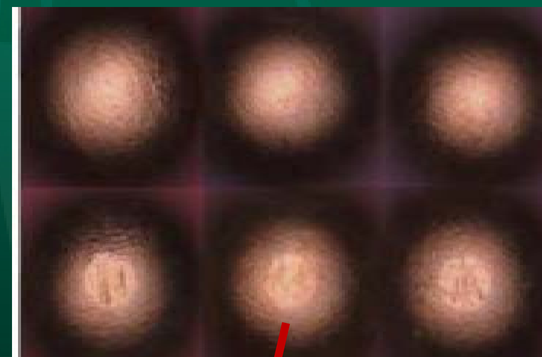
- Characteristics of the probe marks

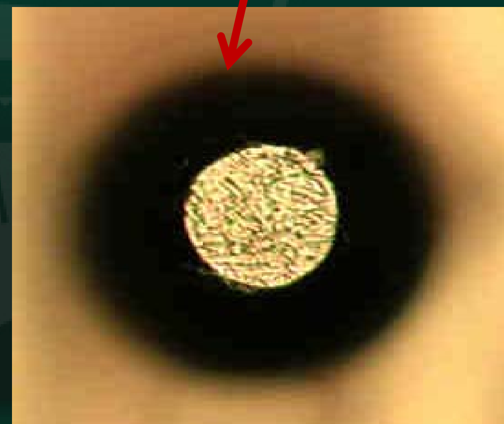
MEMS probe marks





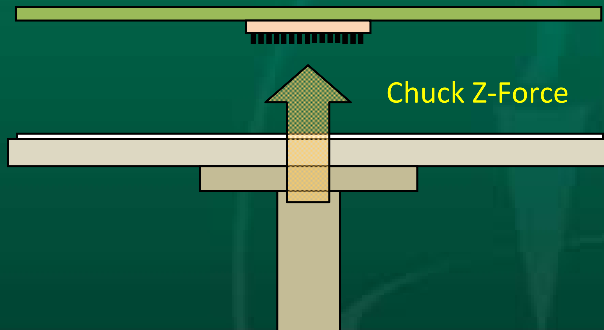
Vertical probe marks





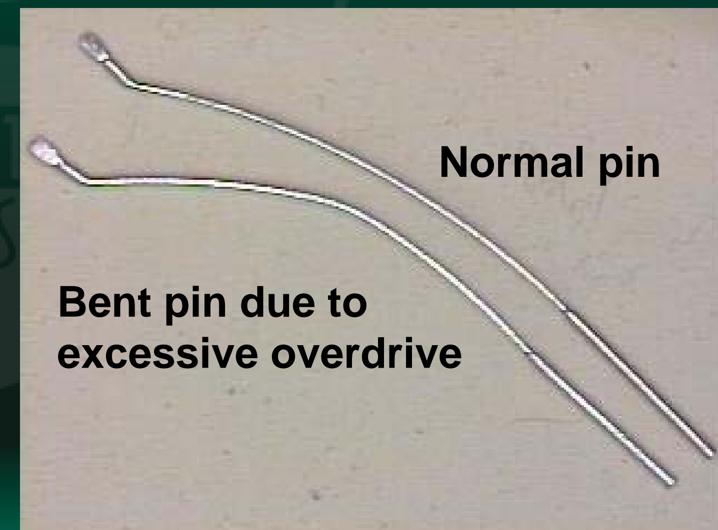
Impact of Higher Chuck Force on Higher Parallelism

Pressure of probe head at center of check



Improper overdrive with excessive chuck force

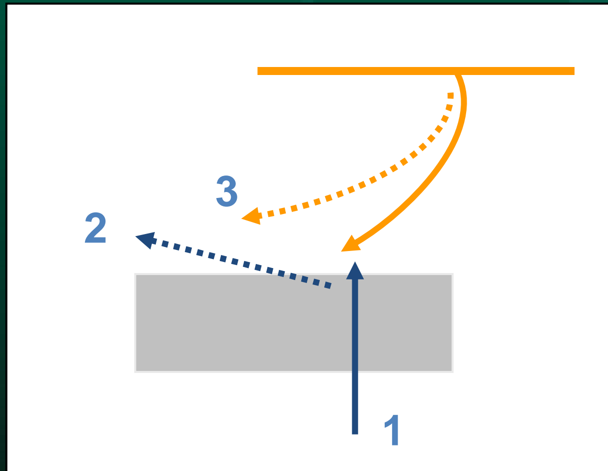
Pressure of probe head at edge of check

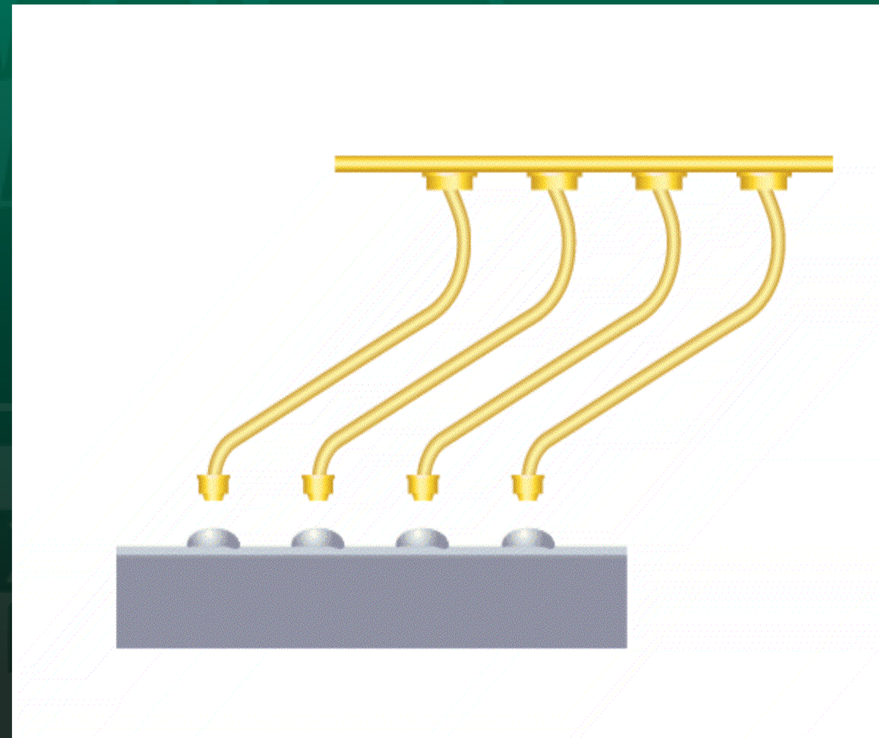


Note : Need to change to a stronger chuck

Overcoming the Impact : MicroForce™ Probing

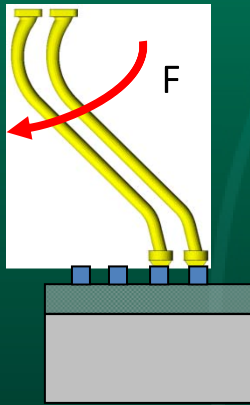
- What is MicroForce™ probing?
  - It is a coordinated X-Y-Z probing motion

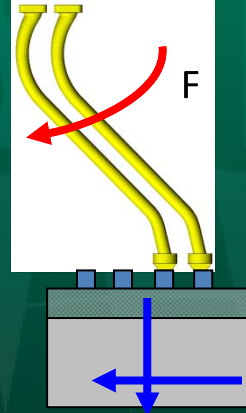


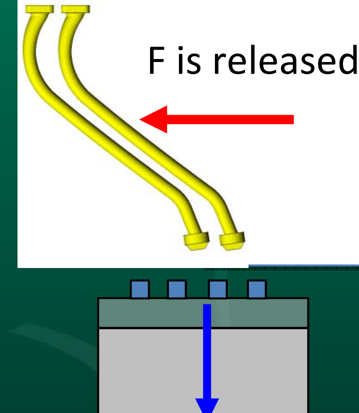


1 – Prober Chuck Moves in Z-axis
2 – Contact with Flip Chip Bump
3 – Chuck moves in X-Y-Z

Improvements on MEMS PC : Enhanced Self-Cleaning MicroForce™ Recipe



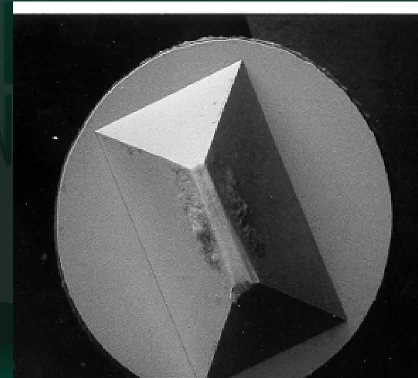




- F has been created during the XYZ Up motion

- Start XYZ Down motion
- Self Cleaning Phase 1

- Start Z only Down motion
- Self Cleaning Phase 2

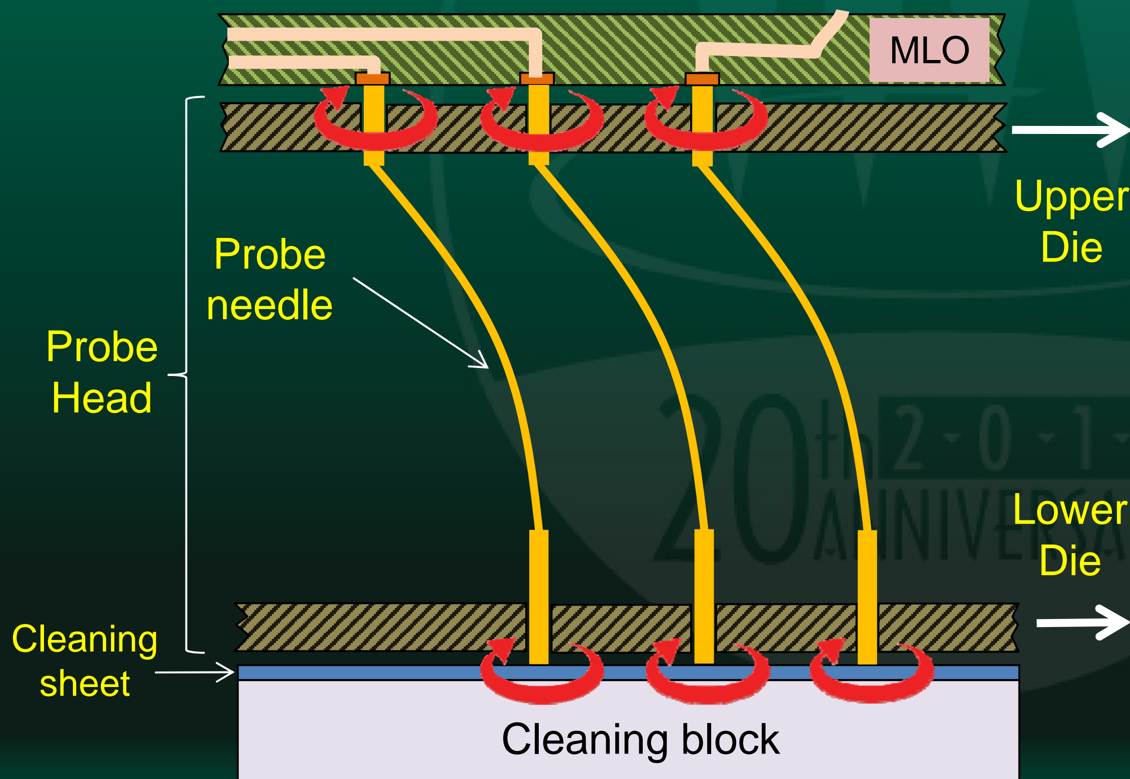


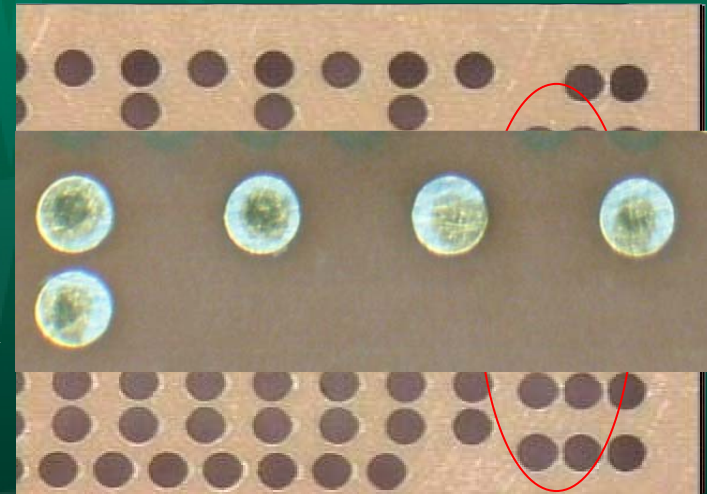
Impact:
With self cleaning option, online cleaning frequency lowered by 16X!!

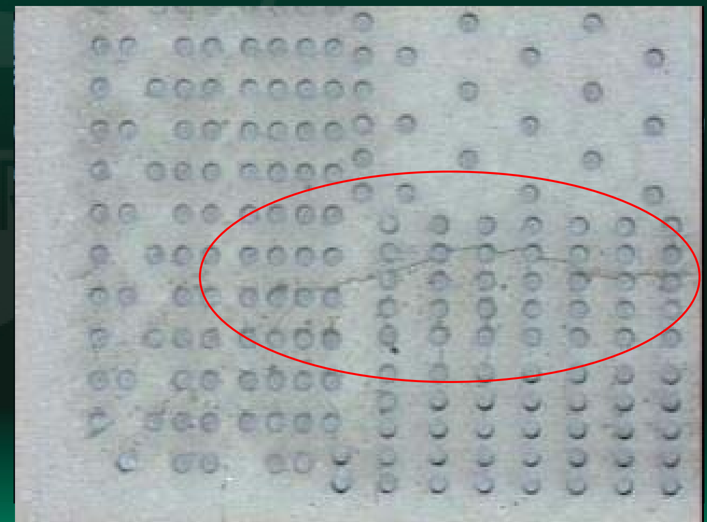
Results : Self Cleaning Effect

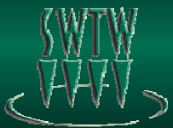
Impact of High Chuck Force on Online Cleaning (Vertical)

- Vertical Probe Head Construct



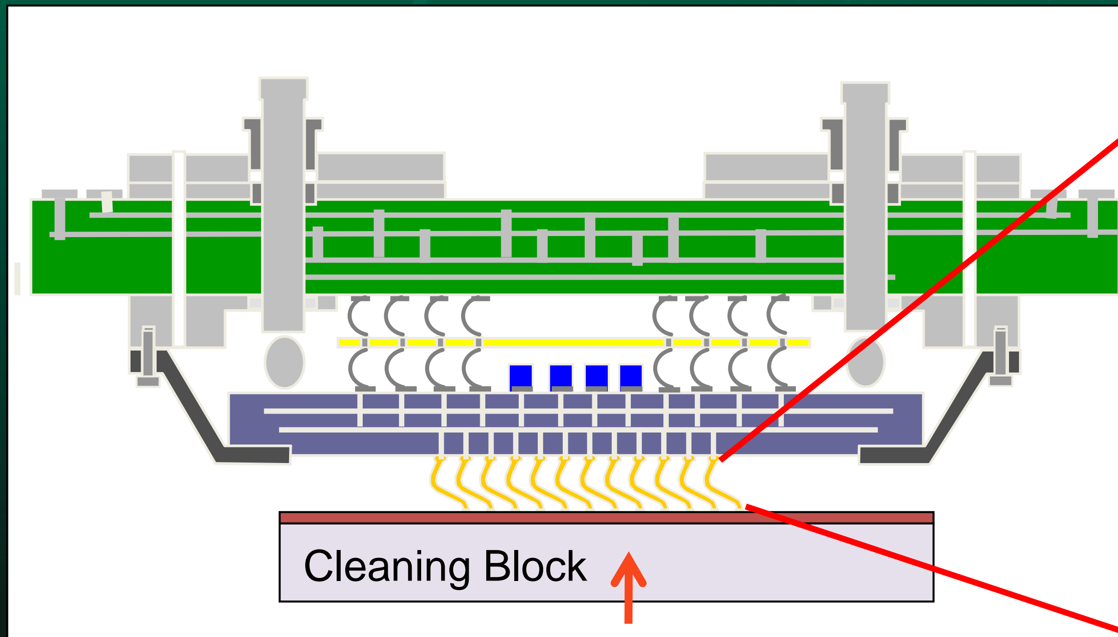


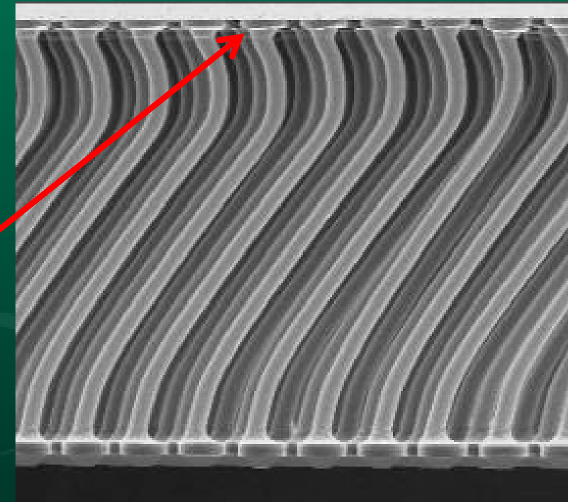


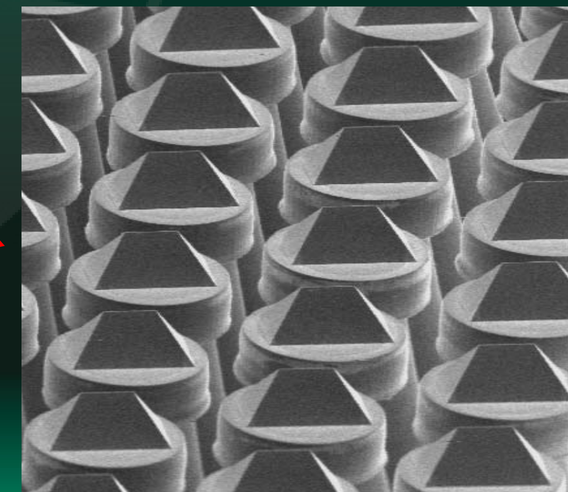


Impact of High Chuck Force on Online Cleaning

- MEMS Probe Head Construct





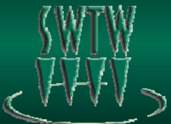


MEMs vs Vertical Probe Cards

- Yield Comparison

Variability Chart for Yield

Yield axis: 70–100. Category: First Pass / Final Pass per wafer. Wafer: 1–22, 24. Card Type: Vertical Probe Card (wafers 1–11), MEMs Probe Card (wafers 12–24). Annotations: First Pass, Second Pass (wafer 4, vertical; wafer 20, MEMs).



Impact of Self Cleaning : Yield

- Significant improvement in yield after implementing self-cleaning

Volume vs. Yield - Weekly Trend Chart
(Dec 2009 - April 2010)

Self-cleaning implemented

250
200
150
100
50
0

99.0
97.0
95.0
93.0
91.0
89.0
87.0
85.0
83.0
81.0
79.0
77.0
75.0

200950 200951 200952 201002 201003 201004 201014 201015

FFI-MEMS - Count of WAFER
Vertical Type - Count of WAFER
FFI-MEMS - Average of CP1_Yield
Vertical Type - Average of CP1_Yield

Impact of Self Cleaning : Contact Sensitive Failures

- Reduction in contact related failures

Implementation of self-cleaning

WWK 200949 200950 200951 200952

Started to see improvements on those test that are sensitive to contact

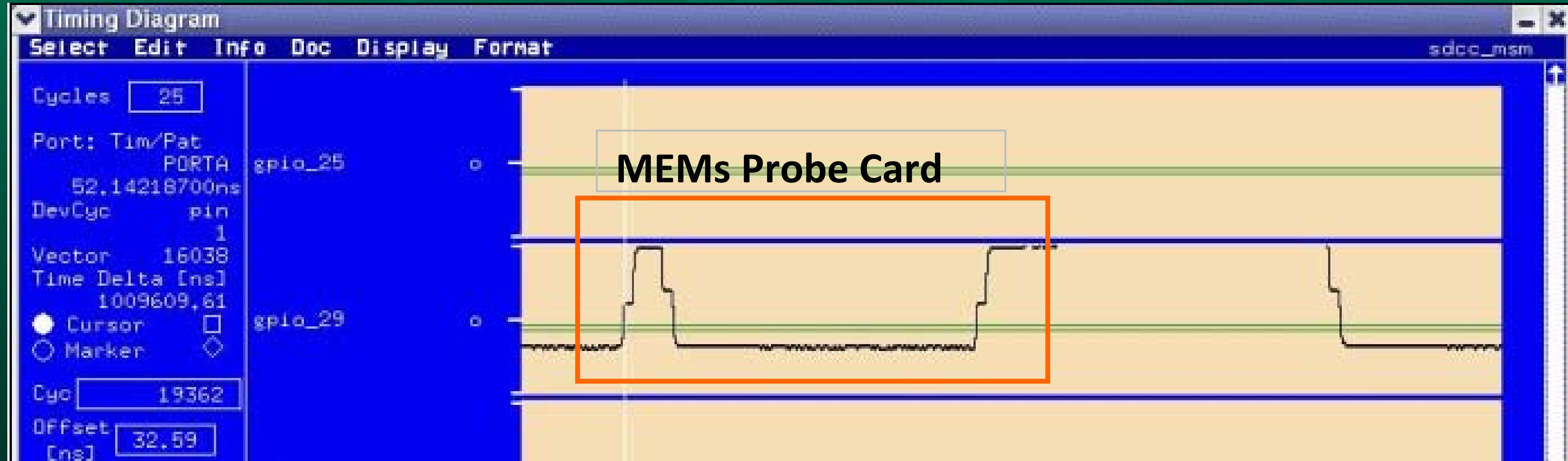
Average

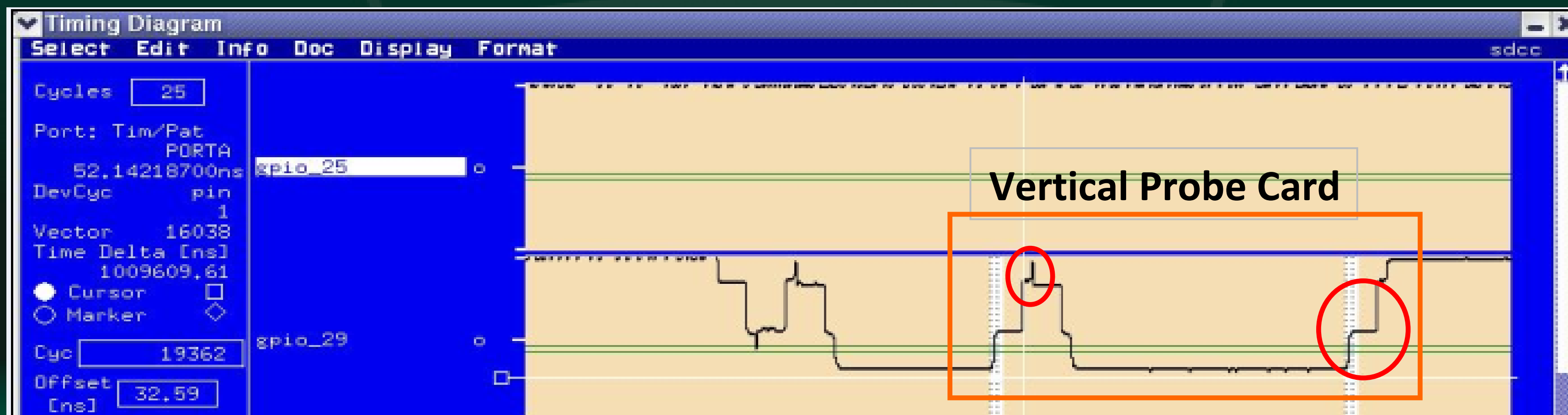
4.91
4.51
4.11
3.71
3.31
2.91
2.51
2.11
1.71
1.31
0.91
0.51
0.11

Other MBIST | Other SCAN | ATPG | CODEC | SCAN_LV | Other MBIST | EFUSE | MBIST_LV | IDDQ ON | IDDQ OFF

Electrical Properties Comparison

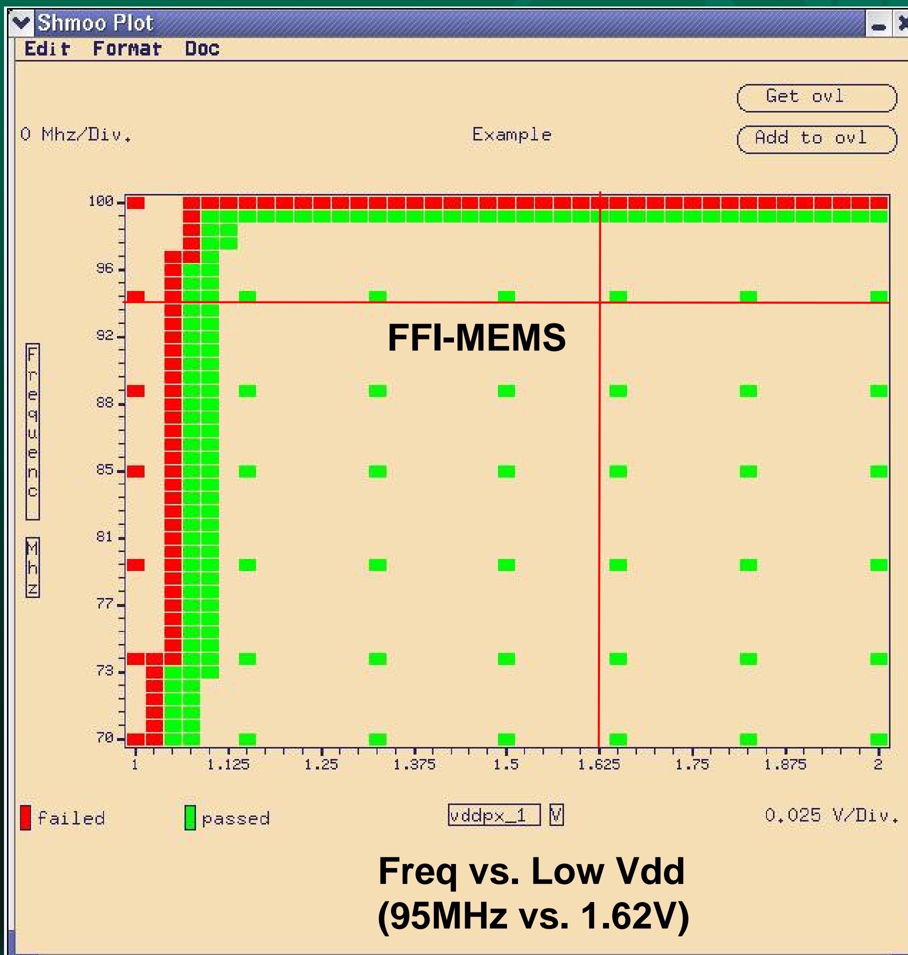
- Experienced timing delay for some functional test block (~15ns)

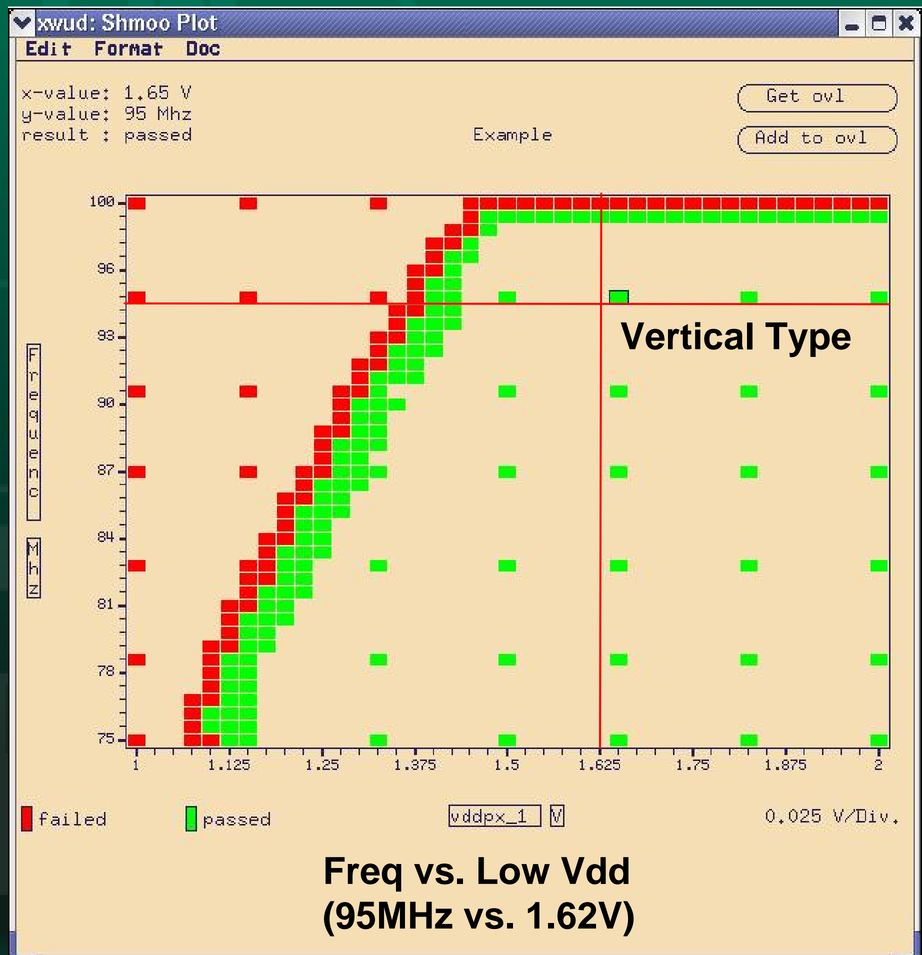




Test Performance Comparison

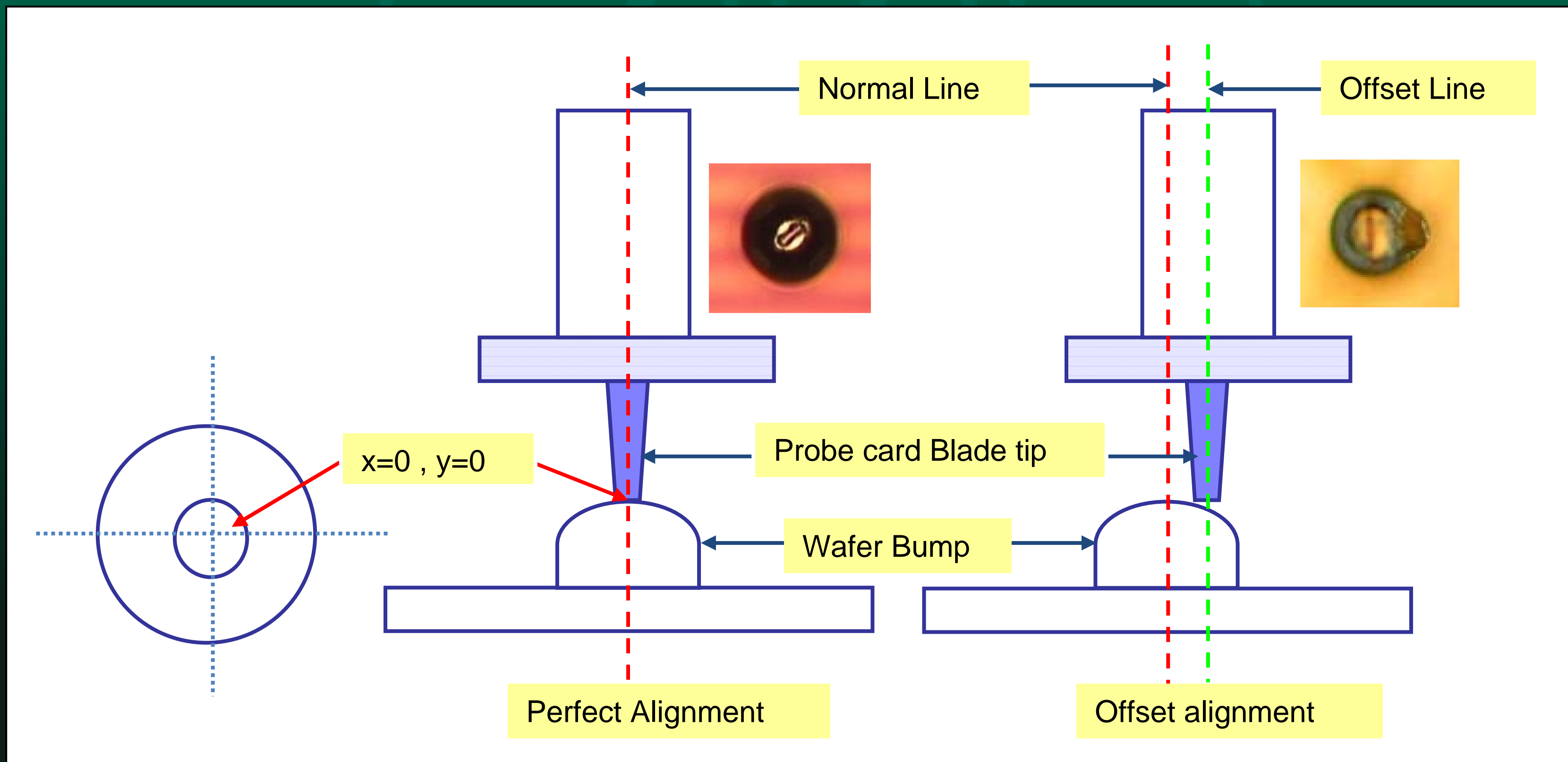
- Experienced better margin in some functional test block





MEMS PC : Caveats

- A tool is only as good as the skills of the user
  - Improper setup leading to quality issue



Summary

- Positive learning
  - Better Yield stability over time
  - Better Electrical performances
  - Lower down time with implementation of online self-cleaning
  - Experienced lower Z-force with MicroForce™ (ease into higher parallelism)
  - MEMs architecture allows easy migration to higher multi sites test
  - Presence of probe mark to help with the setup and troubleshooting
  - No MLC damage with MEMs technology
- Caveats
  - Need to ensure Microforce™ option is installed on prober prior to using.
  - Susceptible to probe mark issue if not setup properly
  - Limited pin replacement capability

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THANK YOU

Q & A

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