Globalization and its Impact on the Probing Process

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FLASH FORWARD

FormFactor

SPANSION

Recent article in EE Times

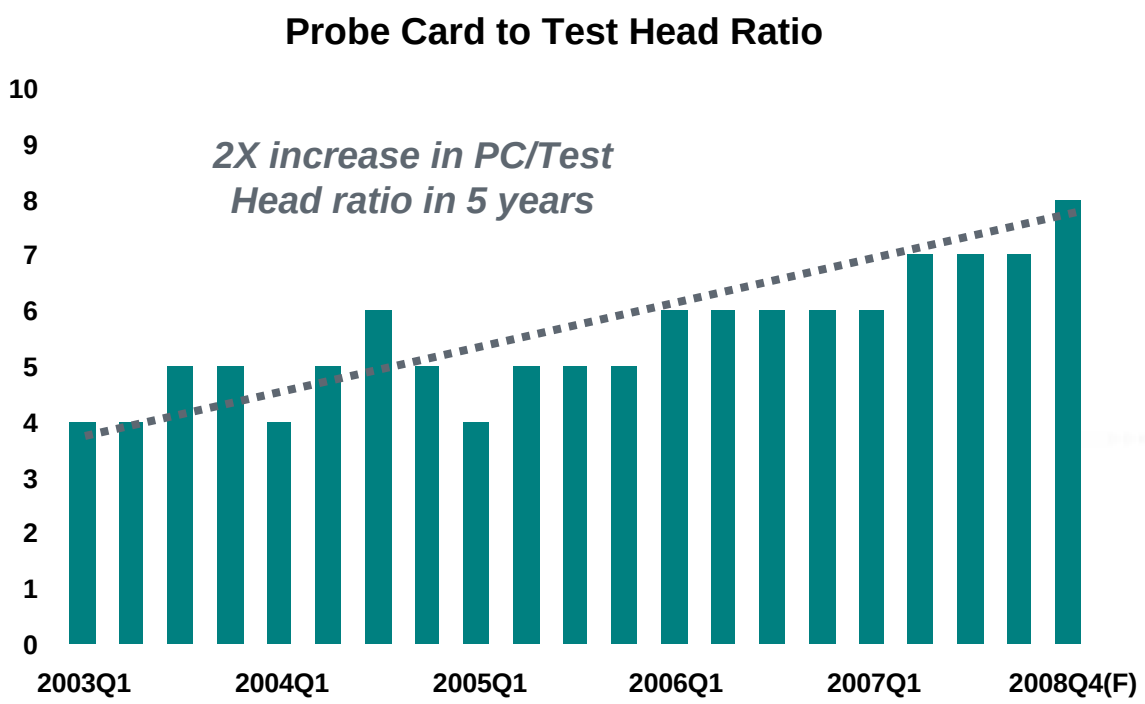
- **Top 20 risk factors for tech companies**

  Junko Yoshida
  (05/19/2008 3:52 PM EDT)
  URL:
  http://www.eetimes.com/showArticle.jhtml?articleID=207801074 MANHASSET, N.Y. —
- What keeps executives at large U.S. technology companies awake at night?
- According to research findings released Monday (May 19) by BDO Seidman, LLP, a professional services firm, not surprisingly, "competition and consolidation in technology sector" came in as their biggest concern (92 percent).
- But tech companies seem to be more worried about risks associated with international operations (85 percent) than the struggling U.S. economy (73 percent).

Executive Summary

- **Global business strategy drives worldwide operation internally and with foundries**
- **Copy-exact and copy-smart are utilized to optimize efficiency**
- **Standards are the foundation, but communication is the key to success**
- **Vendor support is critical to filling the gaps**
- **Correlated metrology and setups build trust and reduce work**

Increasing Test Cell Management Complexity
More probe cards per test cell



- Consumerism increases number of probe card designs
  - 90nm, 65nm, …
  - NOR, ORNAND, MirrorBits …
  - 128Mb, 256Mb, 512Mb, 1Gb…
- More probe card flavors run in production simultaneously
- More complex probe card management to achieve optimal efficiency

Consumer Electronics

Probe Card Support Operations Complexity

One Site

Incoming QA	all new and repaired cards
Vendor control	with SQE support
PM's	each time a card is pulled
Setup expertise	resource to test floor, trouble-shooting
Technology development	Multiple new technologies, upgrades
Experiments	setup recipes, life-time studies, probe marks
Training	new tools, new techs, continuous improvement
Metrology	assure compliance, communication
Data collection and analysis	SPC, limits control
Inventory management and control	PC Tracker
Shipping and receiving	quick and safe transport
Procurement support	support and track open orders
Probe card planning	accurate inventory data
And more	specs, tool mtce, cross-shift ops, etc.

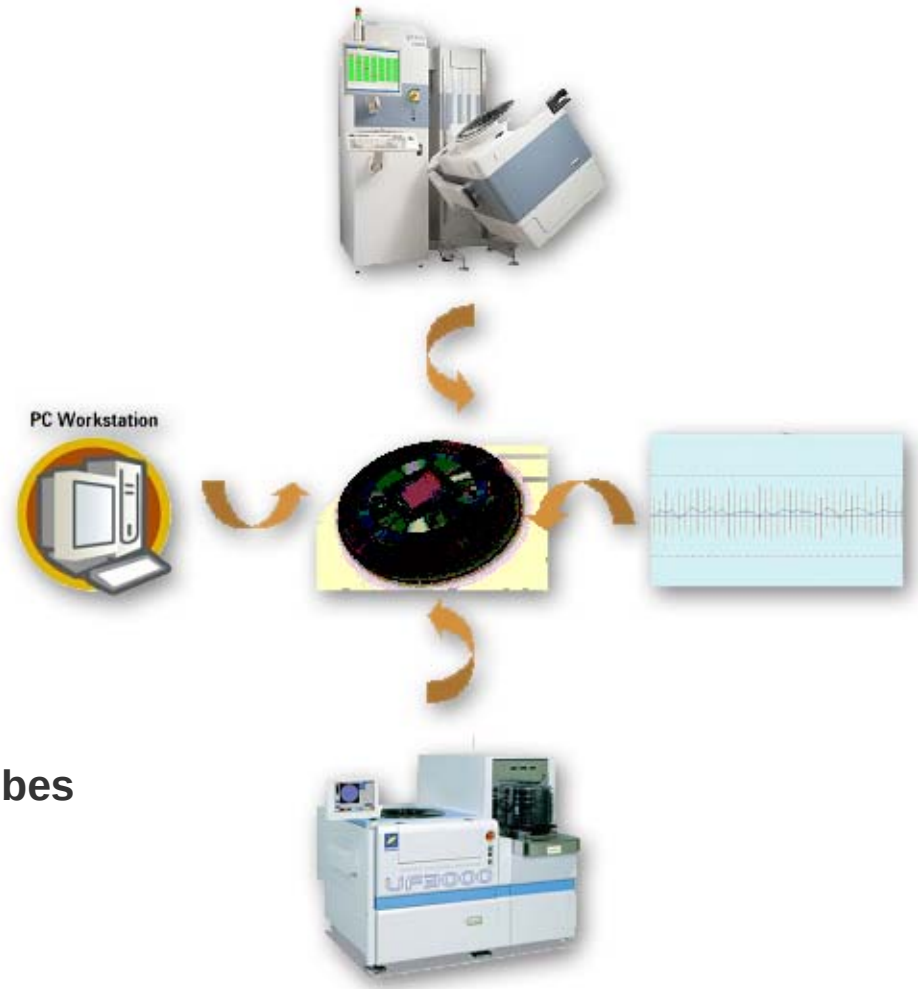
Probe Card Support Operation Complexity
Multiple Global Locations

Even More Complex with Global Operation!

- **Inventory Control & Tracking**
  - **Where's everything? Is it enough?**
  - **Do the right people know?**
  - **What's coming? Is it accurate and current?**
- **Standard Challenges**
  - **Are all the testers and probers matched?**
  - **Will the probe cards perform the same when they arrive at different locations?**
- **Communication internally and externally with vendors**
  - **Tester/Prober/Probe Card/Component Supplier**
  - **Foundry support to ensure copy-exact & copy-smart**

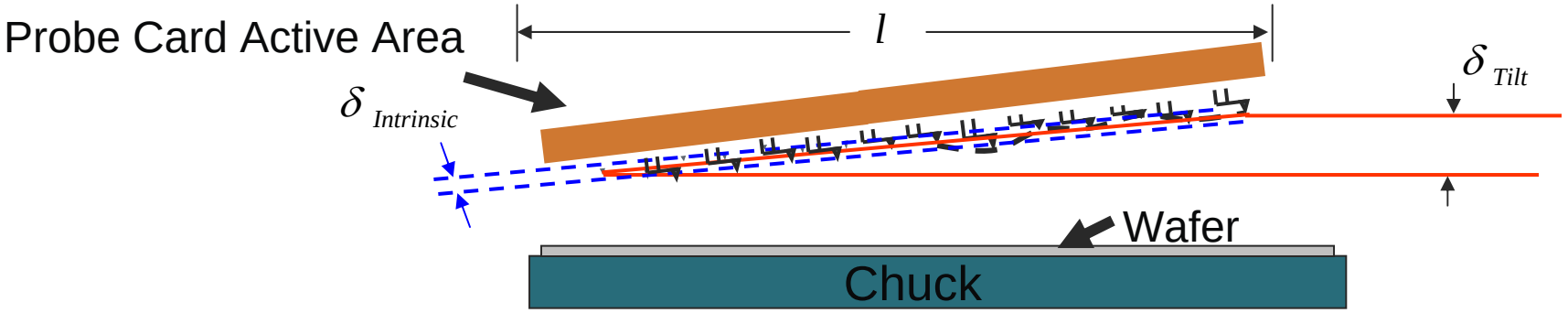
Standards challenges
Many setups potentially impact probe card performance

- **Test Cell Calibration**
  - **Electrical harness**
  - **Mechanical Characteristic**
- **Probe Card Metrology Analyzer**
  - **Parametric**
    - Planarity/tilt, Cres, Lkg, alignment
  - **Repeatability**
    - On same tool and across tools
  - **Simulation**
    - Aluminum vs gold or other
- **Probe Card Setup**
- **Test Programs**
  - **Current clamps to avoid burned probes**
- **Yield Correlation**
  - **Comparable yield from all test cells**



Standards challenges
Correlation Study – Mission Statement

- **Mission Statement**
  - **Optimize correlation of planarity and alignment at all Spansion sort facilities**
  - **Minimize any test cell down-time related to**
    - New card is out of tilt on incoming inspection
    - Cards changing to new testers require tilt adjustments
    - Cards changing test floors require tilt adjustments
    - Alignment paradigms do not correlate



Standards challenges
Correlation Study – Experiment Details

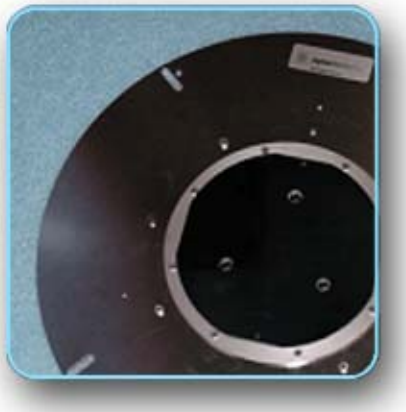
- **Experiment Details**
  - **Step 1: Test cell matching**
    - Agilent VPG System
  - **Step 2: Establish "Golden" PC at Spansion Austin Sort facility**
    - ProbeWoRx 300 for Planarity/Alignment analysis
  - **Step 3: Run "Golden" PC across all Spansion sort feasibilities**
    - Taiwan, Japan, and California

- **Materials**
  - **One FFI PH100 probe card**
  - **Test Wafers of same product type**

Standards challenges
Correlation Study – Step 1: Test Cell Matching

Step 1: Test Cell Matching

- **Utilize VPG calibration tool to make prober and test head parallel**
- **Calibrated > 200 test cells**
- **Once set, remains stable < 8 um**
  - **Vendor specification < 20um**



Verigy VPG calibration system

TESTER	PM DATE	TOLERANCE	DELTA	1	2	3
Tester 1	18-Sep-06	IN	3	20728	20726	20725
"	13-Sep-06	IN	3	20731	20729	20732
"	8-Aug-06	IN	4	20721	20724	20720
"	11-Jul-06	IN	4	20739	20735	20739
Tester 2	18-Sep-05	IN	5	20539	20535	20540
"	20-Aug-06	IN	5	20506	20509	20511
"	26-Jul-06	IN	2	20506	20508	20507
"	NA	IN	7	20521	20520	20527
Tester 3	15-Sep-06	IN	8	20642	20645	20637
"	1-Sep-06	IN	3	20640	20640	20643
"	17-Aug-06	IN	4	20643	20643	20639
"	20-Jul-06	IN	3	20623	20620	20621

Standards challenges
Correlation Study – Step 2: Establish "Golden" PC

Step 2: Establish "Golden" Probe Card

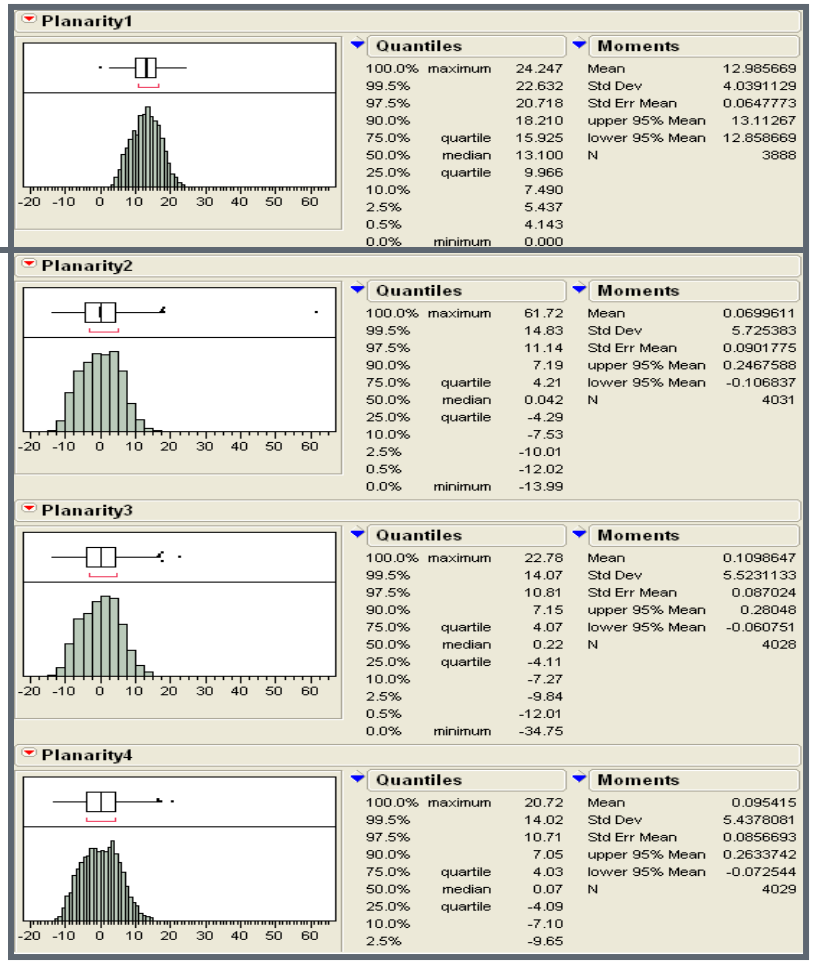
- **The ProbeWoRx 300 is Spansion's tool for analyzing large array probe cards.**
- **The test run at FFI mirrored the standard production flow**
  - **Check the monitor card on PWX to make sure SPC passes**
  - **Test 3 runs for PA (removing and reinstalling the probe card) without any tilt adjustment to establish Disturbed Repeatability**

ProbeWoRx 300 by Rudolph Technologies for analyzing large array probe cards

Standards Challenges
Correlation Study – Step 2: Planarity

Spansion Measurement

FFI 3 measurements



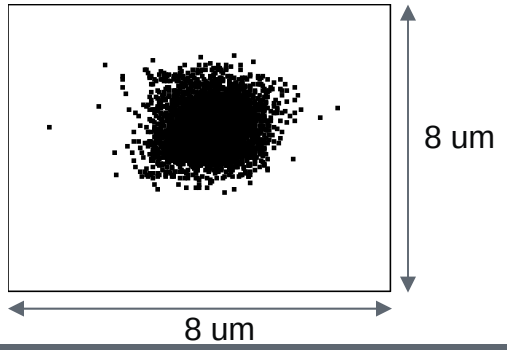
- **Planarity correlated between Spansion and FFI**
- **Different measurement mode**
  - **Spansion – First to Last**
  - **FFI – Median**
- **Measurement was repeatable at FFI**

Standards Challenges

Correlation Study – Step 2: Alignment

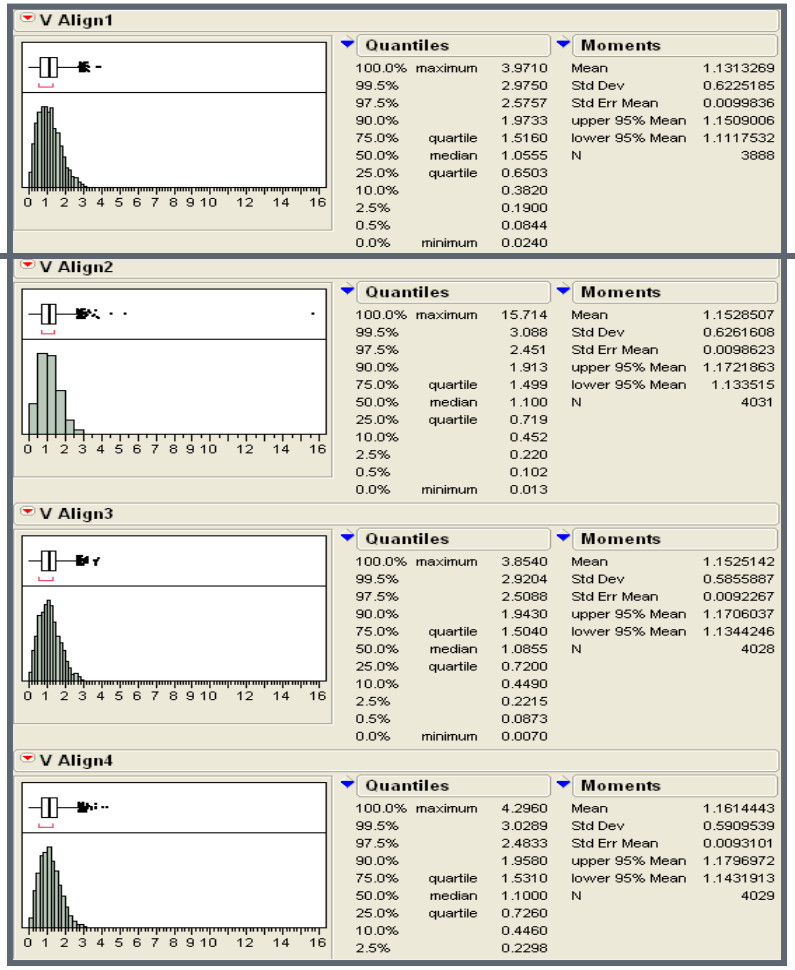
Spansion

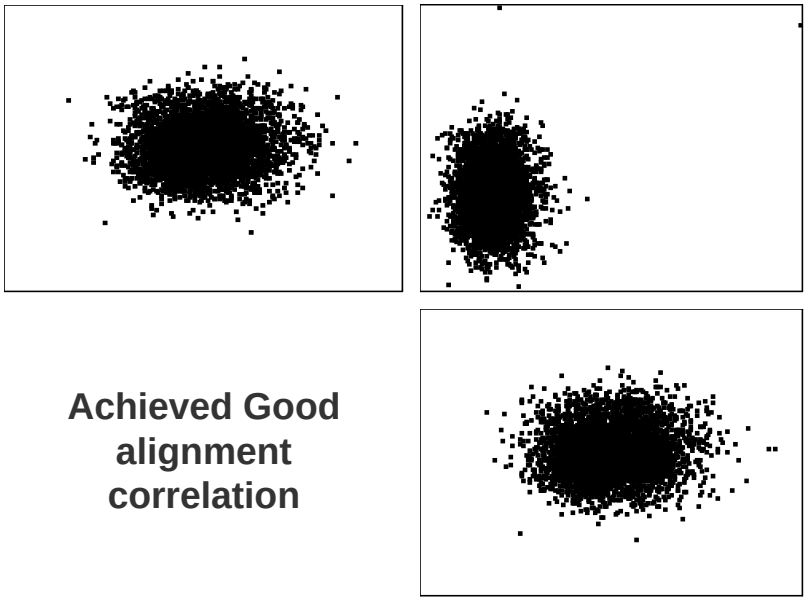
Measurement



FFI

3 measurements



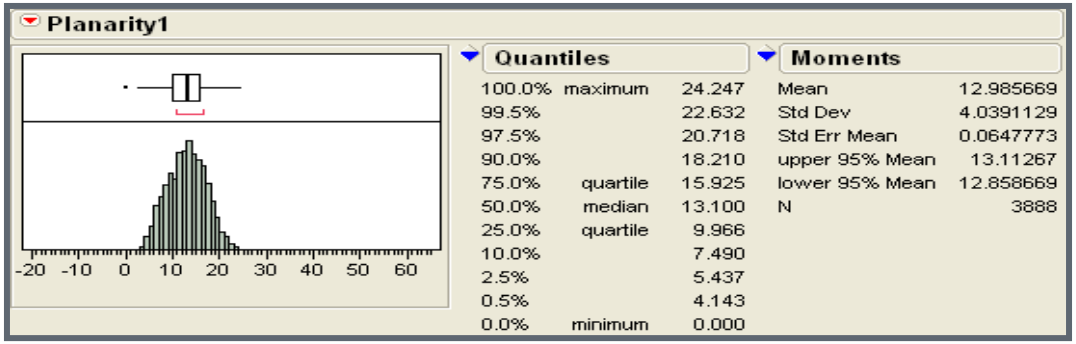


Achieved Good alignment correlation

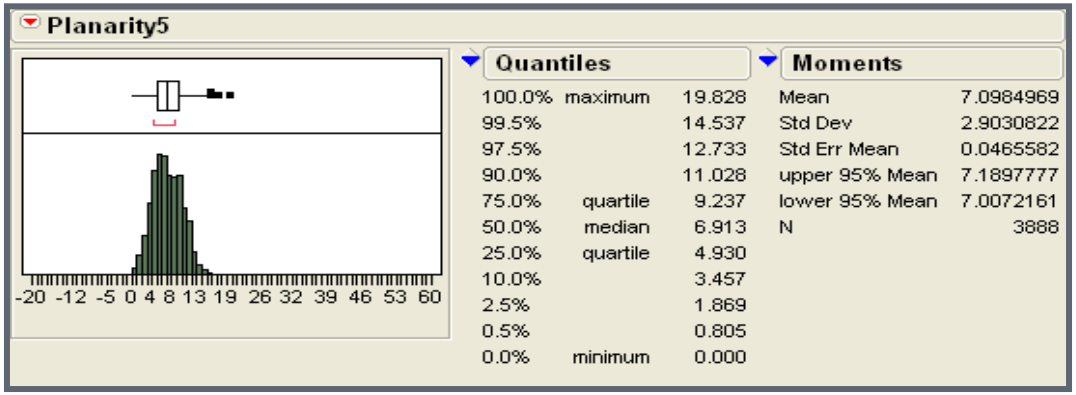
Standards Challenges
Correlation Study – Step 3: Across Spansion Sites

Planarity

Spansion Measurement



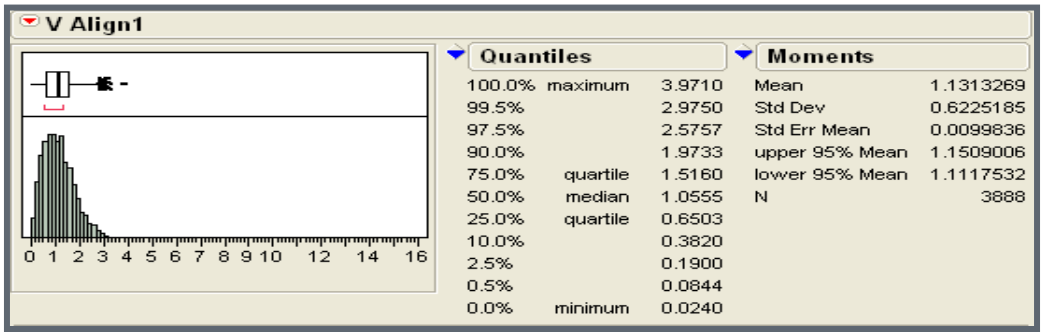
ChipMOS Measurement

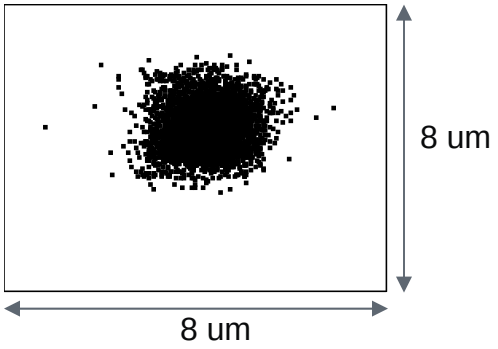


Standards Challenges
Correlation Study – Step 3: Across Spansion Sites

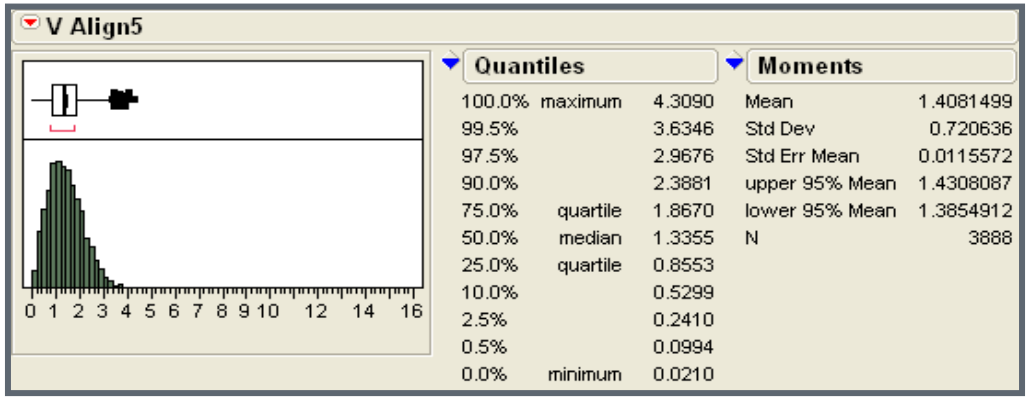
Alignment

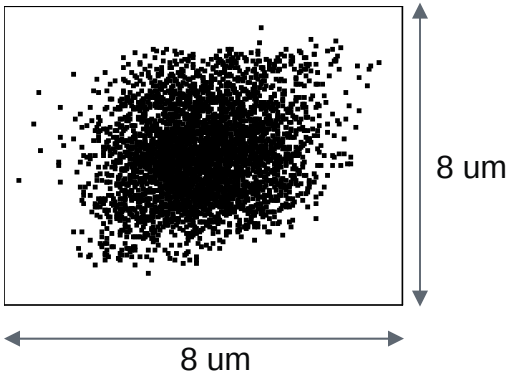
Spansion Measurement





ChipMOS Measurement





Standards Challenges
Conclusions

- **This correlation work ensures “out-of-box” functionality of probe cards and minimize test cell down-time**
  - **VPG calibration eliminated planarity tilt variation**
  - **Verified Probe Card metrology tools (ProbeWoRx) are correlated to the sort testers and to each other**
  - **“Golden” card was utilized to establish correlation between Spansion sites**
- **Next step will be to perform a probe mark study across all test floors globally.**
- **Goal is to develop a process to easily and quickly audit the test floors for continued compliance to the tilt standard.**

Global Communication

- **Collaboration with vendors**
  - **Partners with foundries**
  - **In-house vendor support**
    - Repair
    - Training
- **Many customers vs many suppliers**
- **Weekly meetings**
- **Management and Planning**
  - **Web-tools**
  - **Cost reduction opportunities**
  - **Pictures**

Frequent communication and close collaboration are key to success

Summary

- Global business strategy drives worldwide operation internally and with foundries
- Standards are the foundation, but communication is the key to success
- Close collaboration with vendors is critical to filling the gaps
- Correlated metrology and setups build trust and reduce work

Acknowledgement

- Special thanks go to …
  - Spansion Probe Card Team
  - ChipMOS Probe Card Team
  - Jason Liew at FormFactor
  - Randy Parks at FormFactor