
Leakage Monitoring and Control with an Advanced e-beam Inspection System

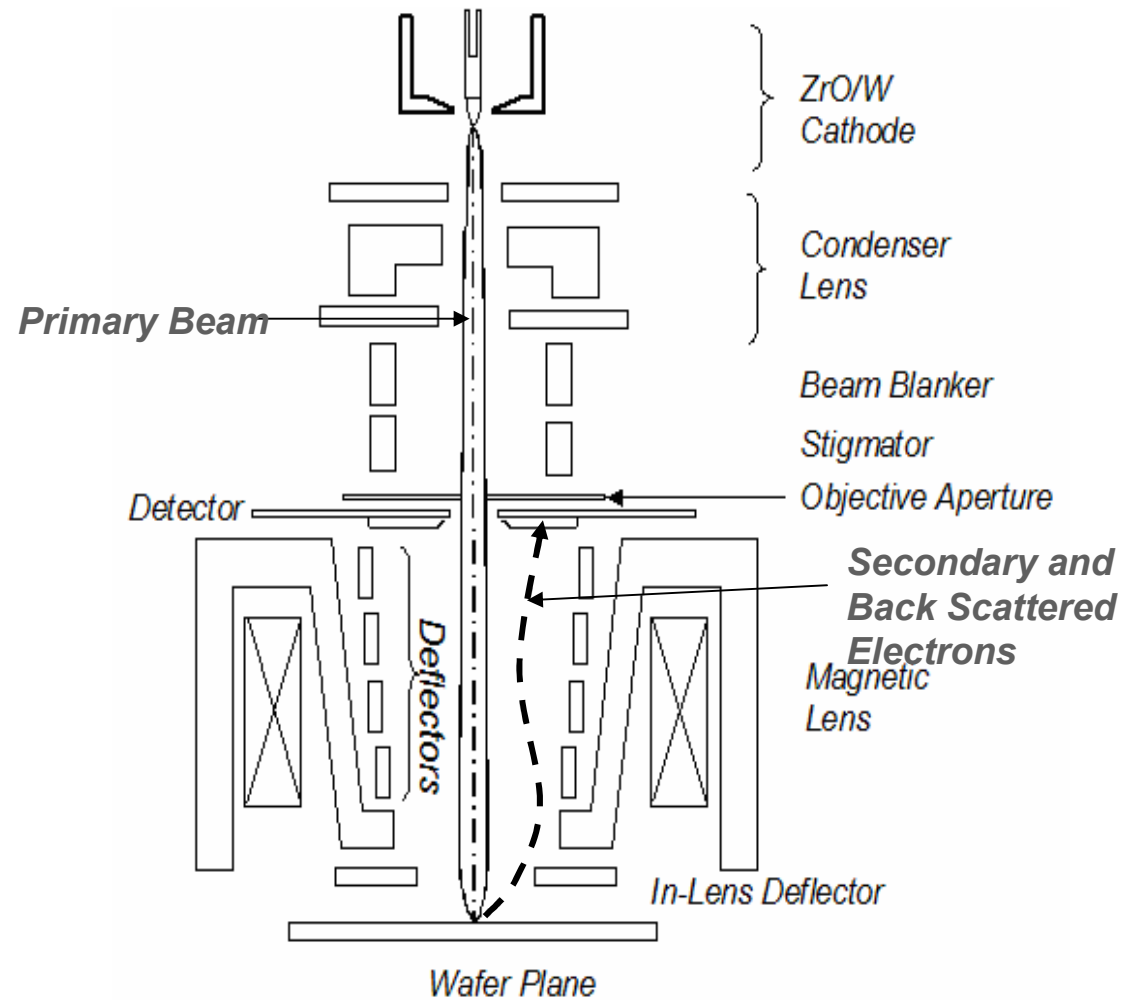
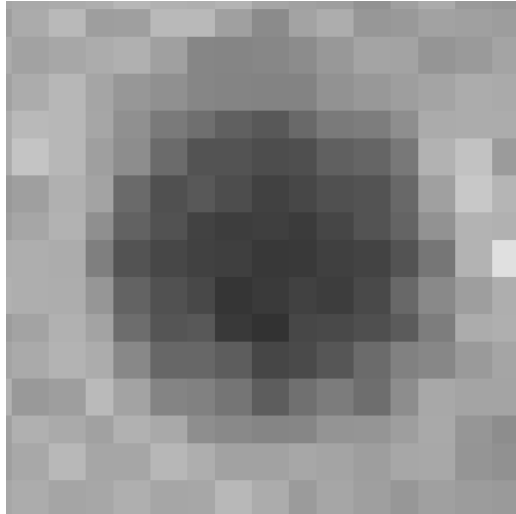
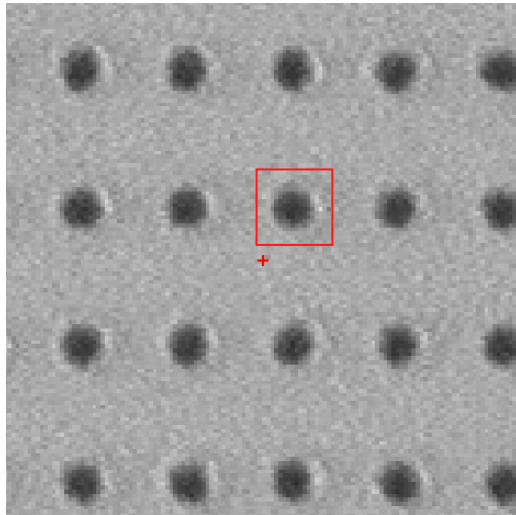
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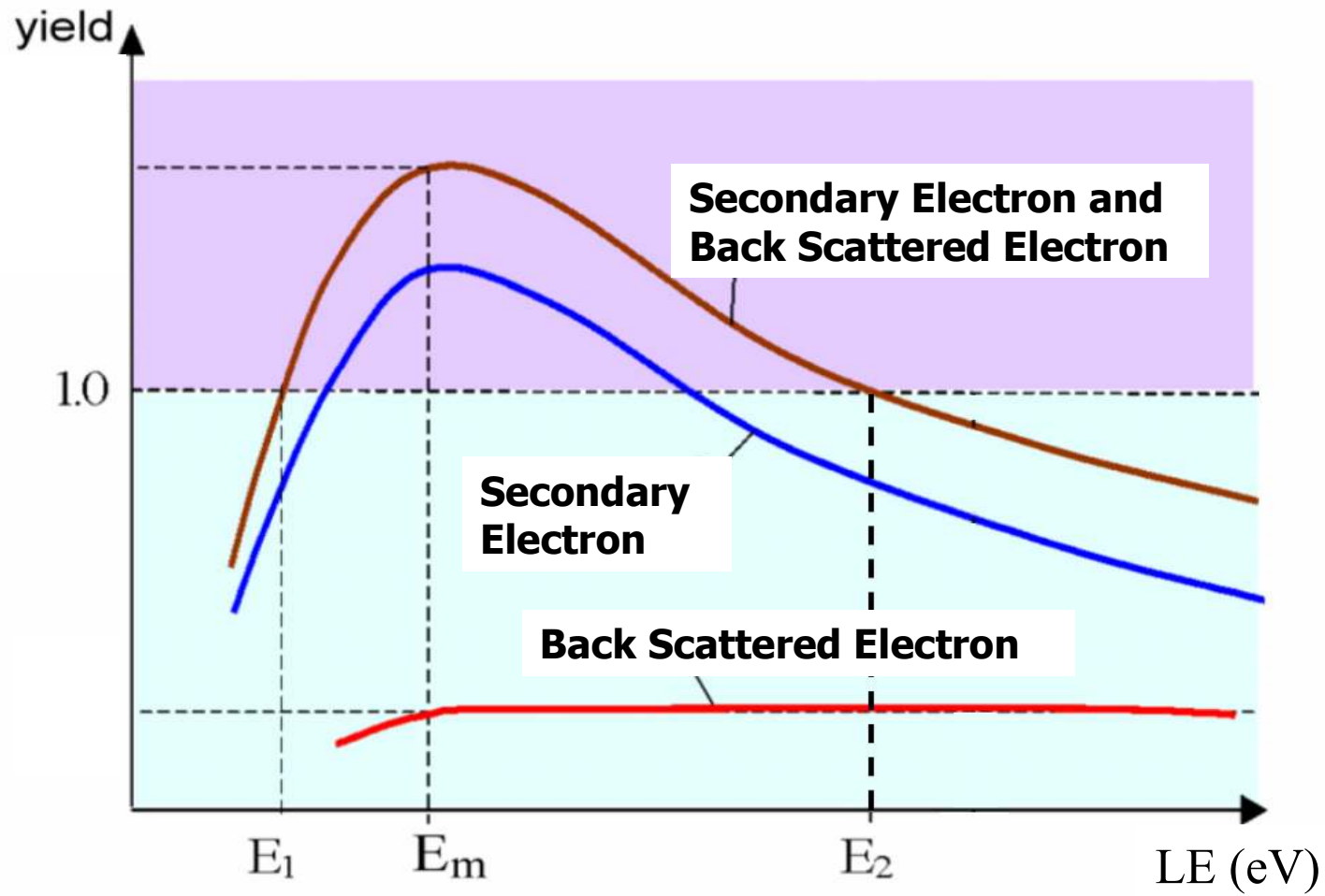
List of Topics

- **Introduction to EBI**
- **Principle of detection**
- **Experiment arrangement**
- **Experiment results**
- **Conclusions**

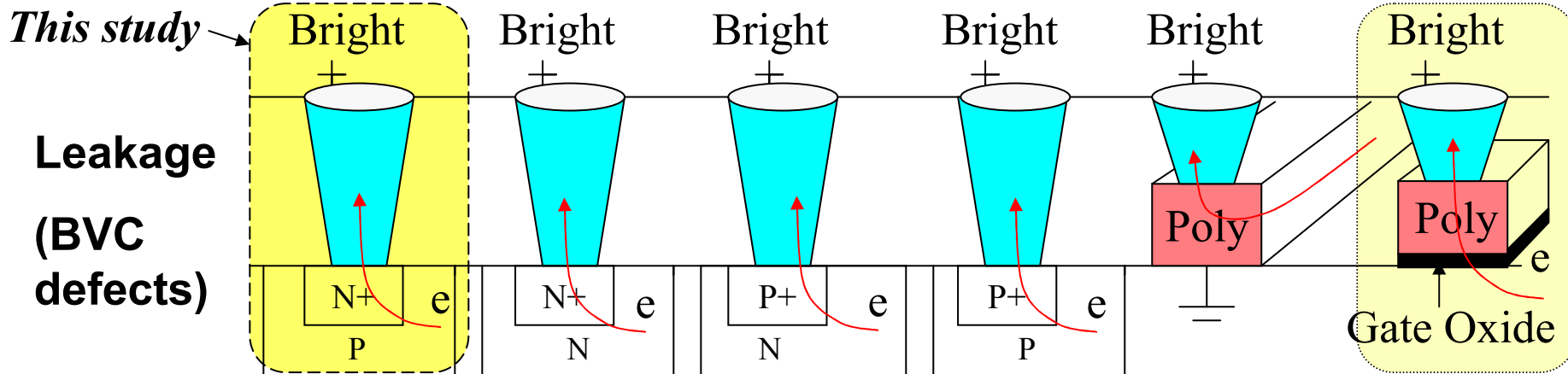
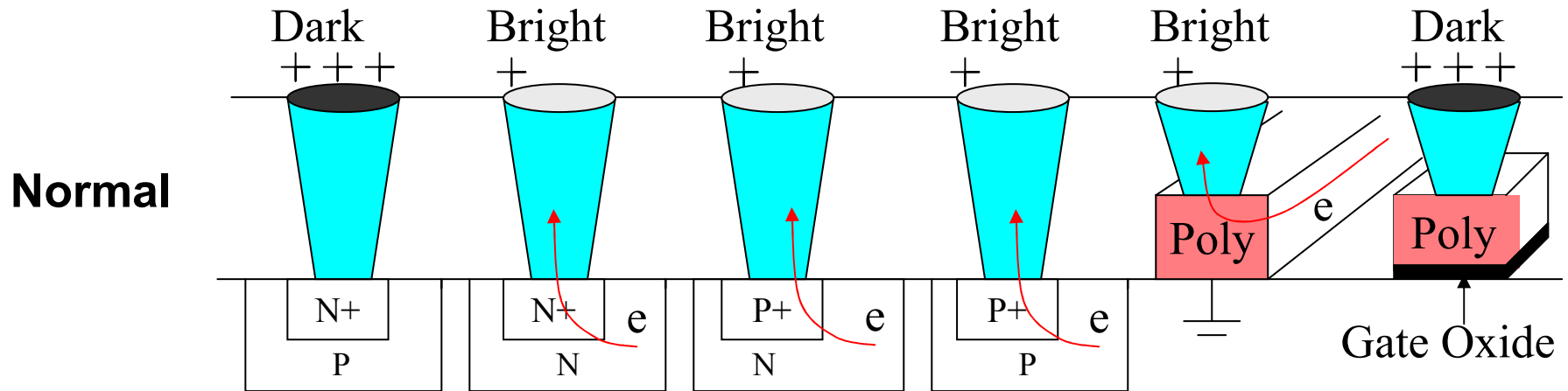
Illustration of eScan®300



Positive Mode



W-Plugs & VC in Positive Mode

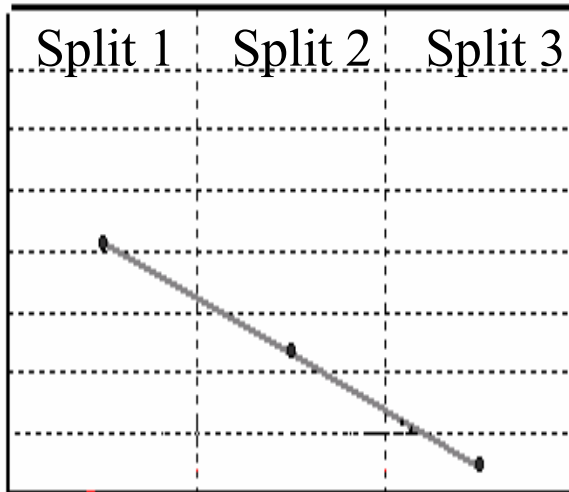


Experiment 1

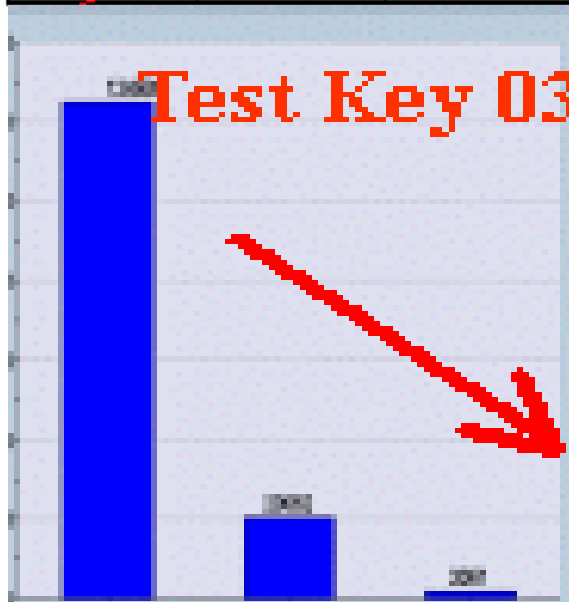
- **6 wafers**
- **3 ion implantation conditions**
- **After WCMP**
 - **One wafer from each condition send to inspection**
 - **Another one continue to M1 for WAT**
- **Inspected and measured test keys and SRAM arrays**

Correlation of WAT and eScan®

Leakage Current



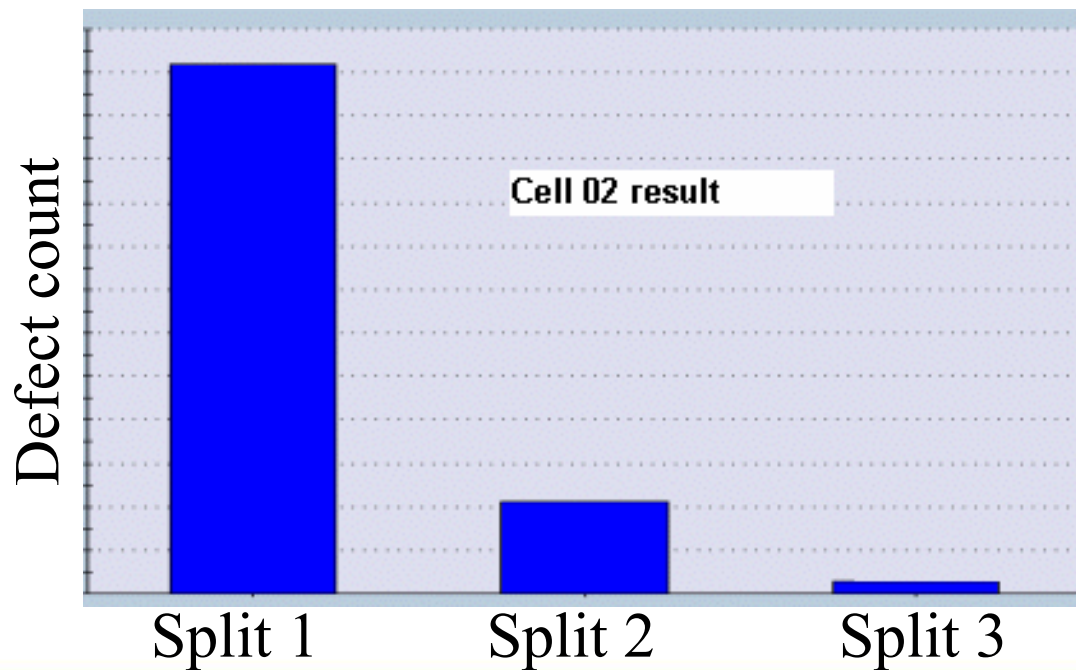
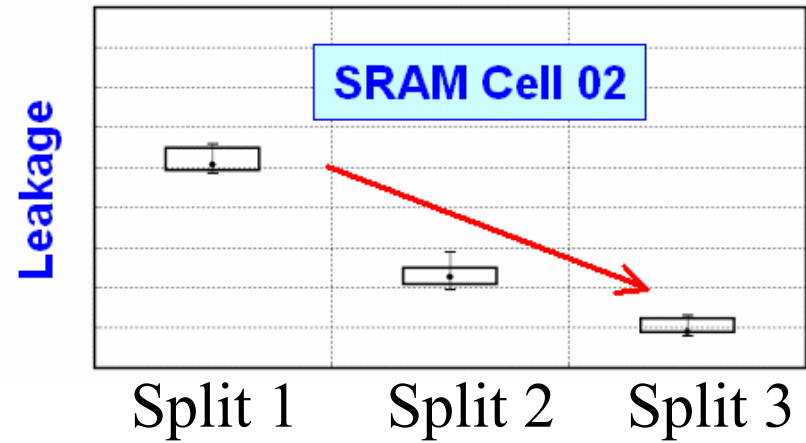
BVC Defect Count



BVC Defect



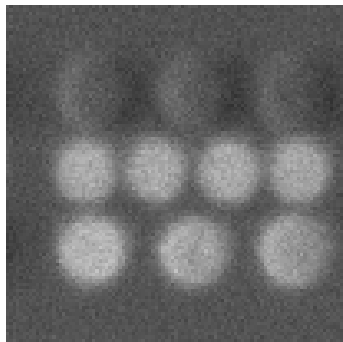
Correlation of WAT and eScan®



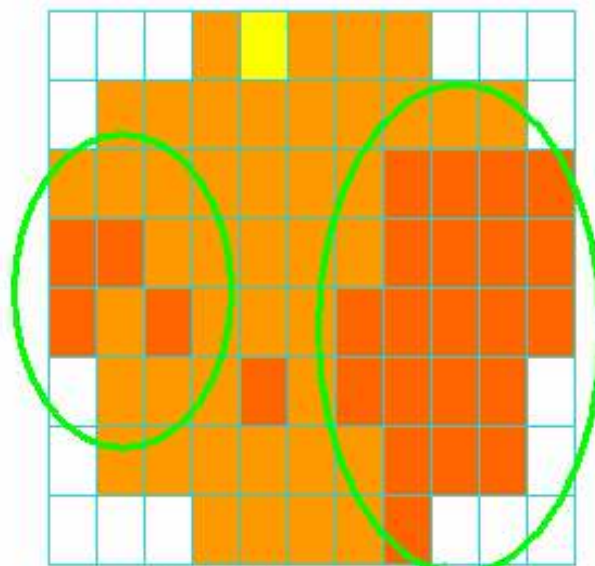
GLV Binning

- **Strong leakage causes high GLV**
- **Auto binning GLV of all BVC defects**
- **High GLV BVC map matches with high leakage current map very well.**

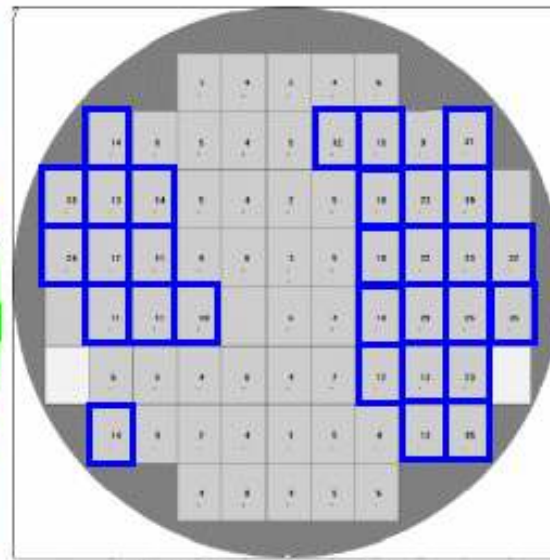
WAT Leakage Map and eScan BVC Map



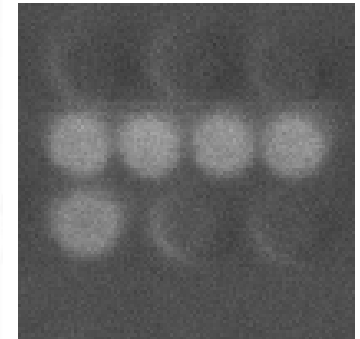
GLV1



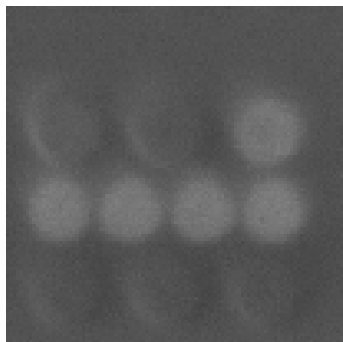
WAT Map



BVC Defect Map



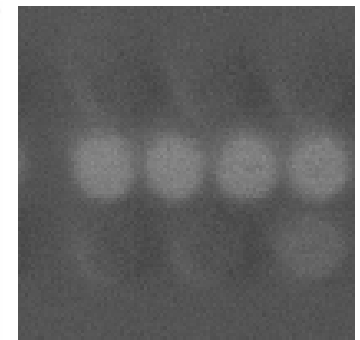
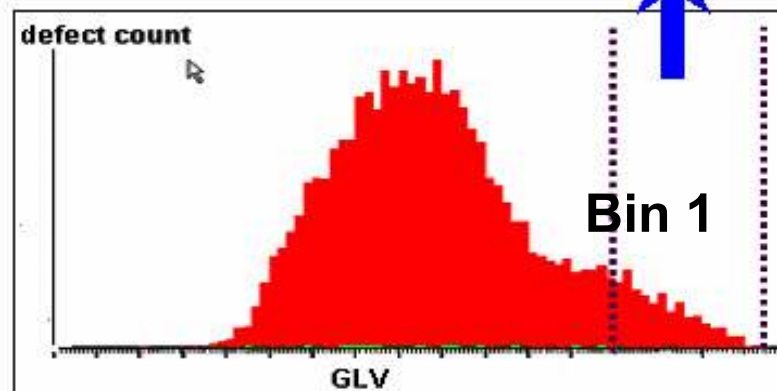
GLV2



GLV3

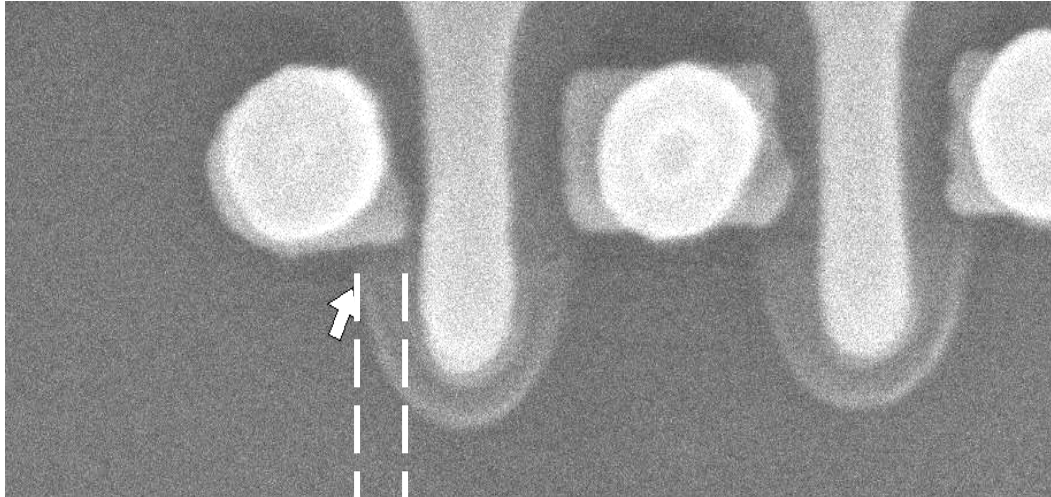
Higher N+/P-well leakage

High Gray Level / High Correlation

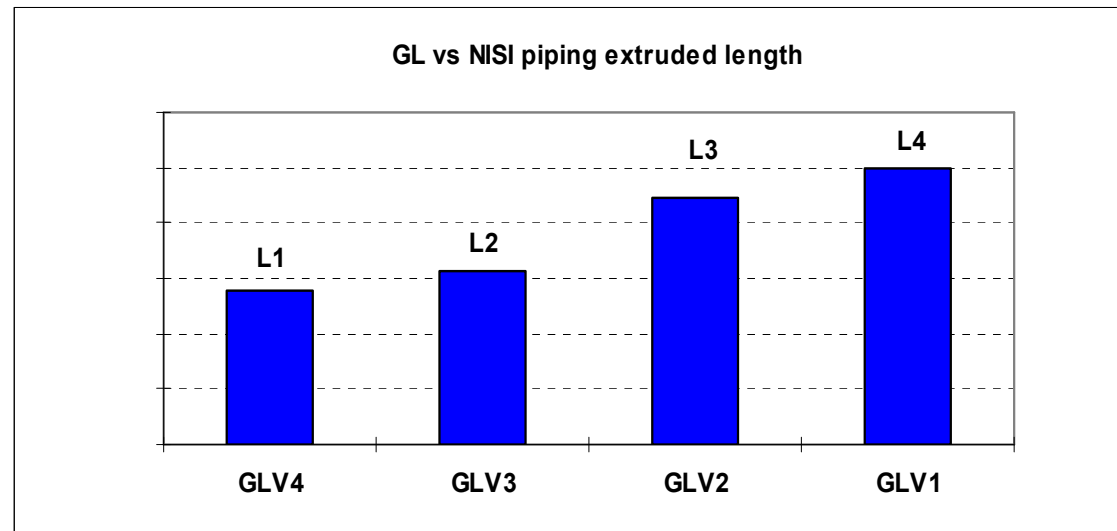


GLV4

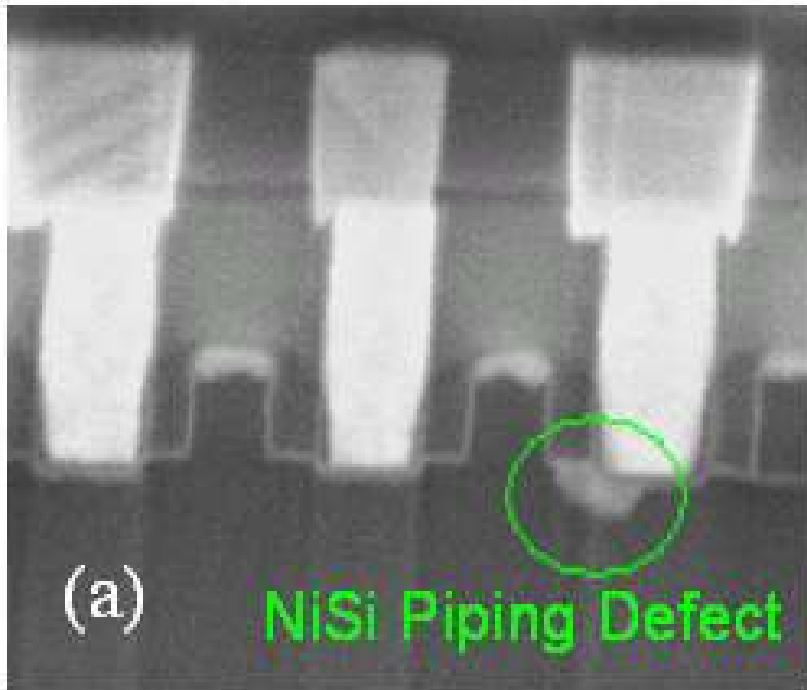
Extrusion Length vs eScan GLV



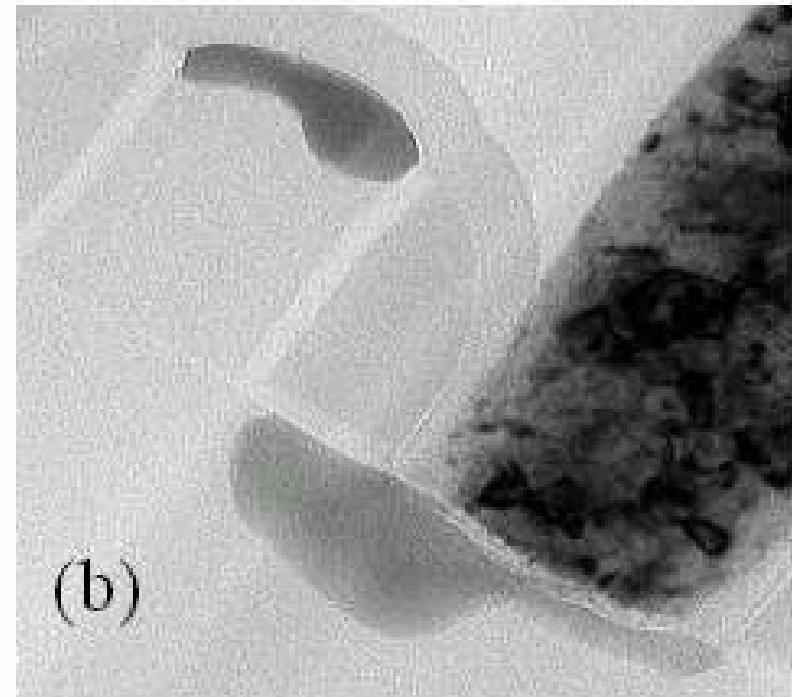
Extrusion length



NiSi Diffusion



SEM



TEM

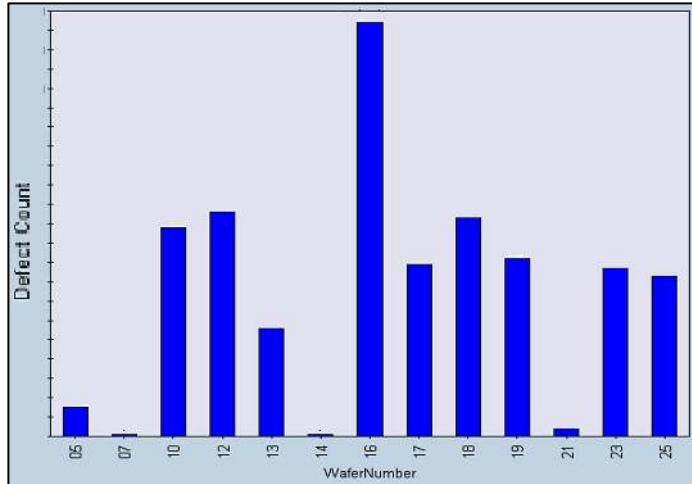
Leakage is caused by NiSi diffusion

Experiment 2

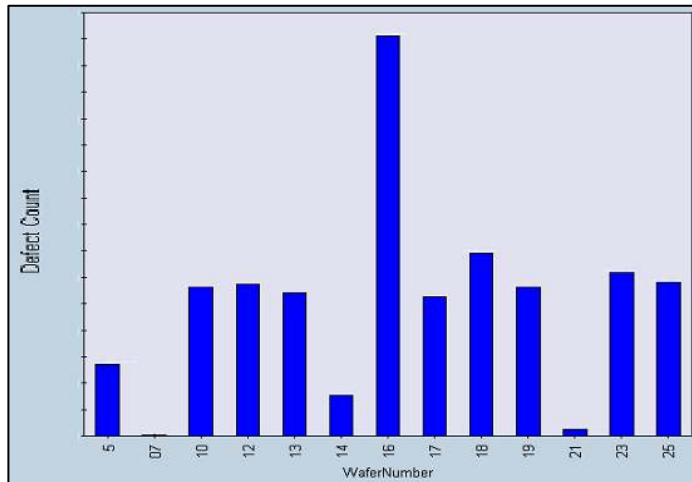
- 13 wafers
- 3 ion implantation conditions
- eScan inspection on two test keys
- WAT after M1 CMP

BVC counts vs. WAT Leakage

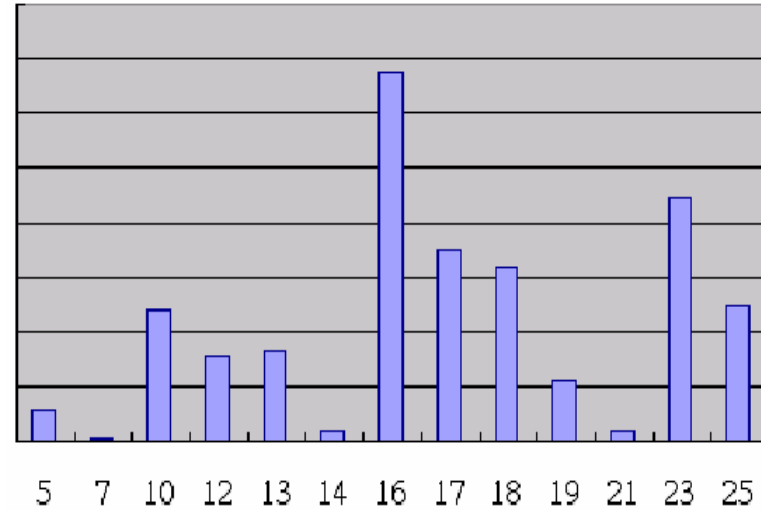
Test key 1



Test key 2

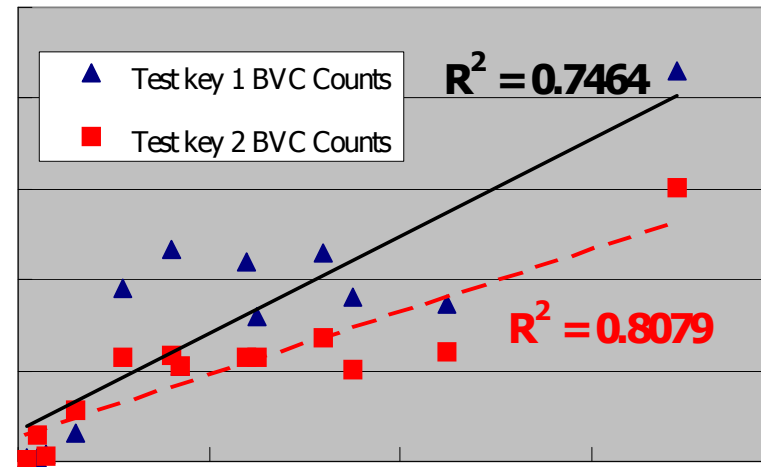


Leakage current



WAT

Leakage current



BVC counts

Conclusion

- BVC defects of W-plugs that connect to NiSi on N+/P-well junction on both test key structures and SRAM array
- BVC defect counts correlate with WAT leakage current on both test key and SRAM
- FA delayer showed that N+/P-well leakage is caused by nickel silicide diffusion
- Extrusion length of the nickel silicide strongly correlates with GLV of the W-plug
- BVC counts strongly correlate to WAT leakage current

Development

- More EBI systems:
 - Leap Scan EBI : eScan®310, eScan®315 (Improve resolution)
 - Continue scan EBI : eScan®Lite (Improve throughput)
 - Hotspot EBI: eP2
- More EBI applications
 - Monitoring hole non-open at contact AEI and WCMP.
 - Qualifying the contact lithography process window.
 - Negative Mode™ EBI for P+/N-well leakage detection.
 - Monitoring NMOS and gate leakage right after NiSi formation.