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

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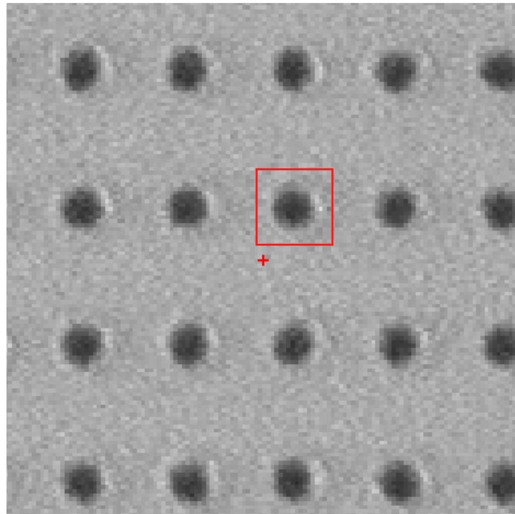
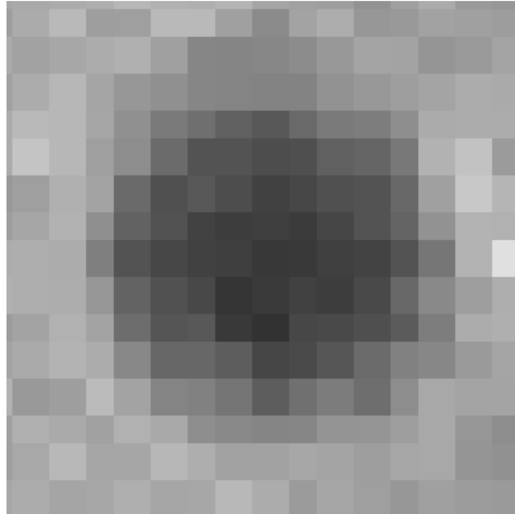
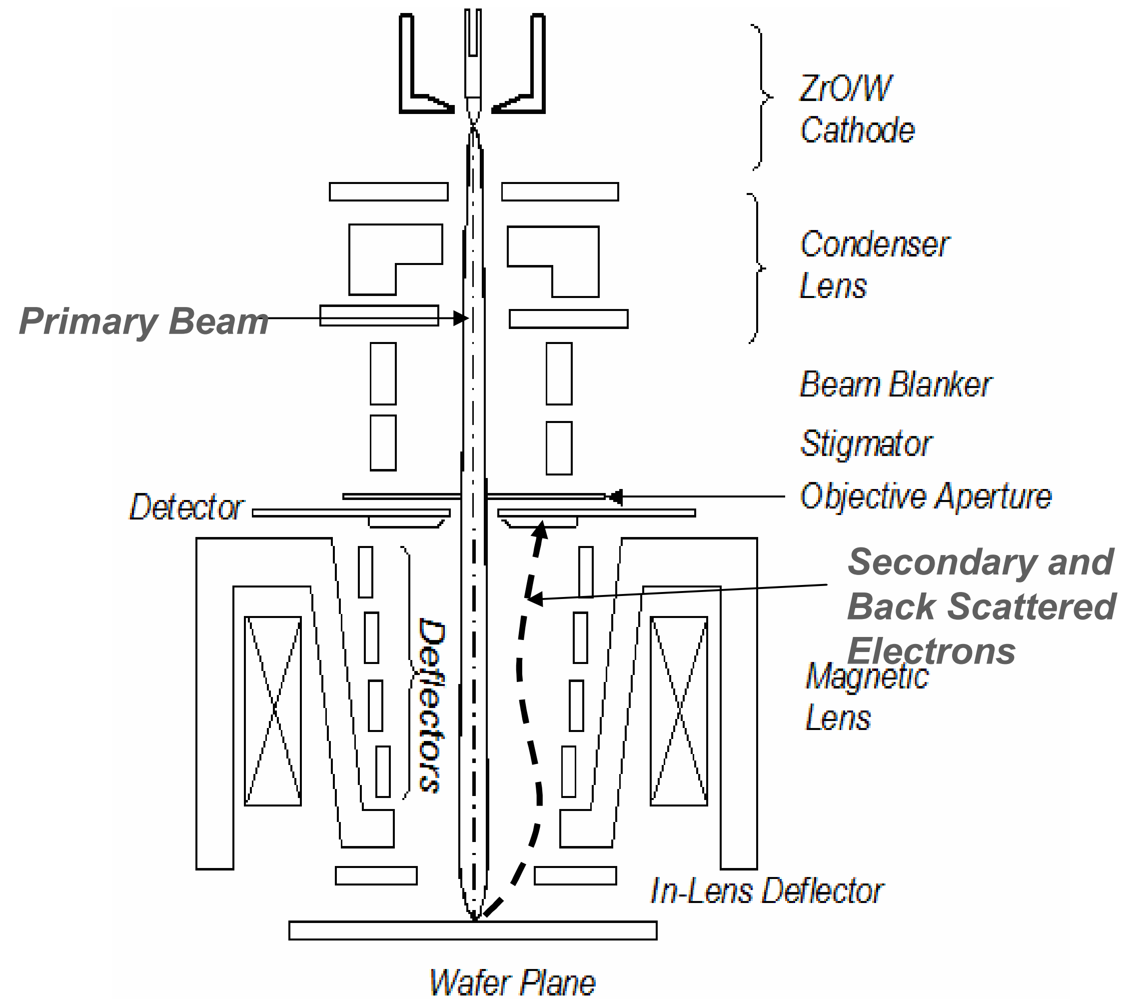
List of Topics

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

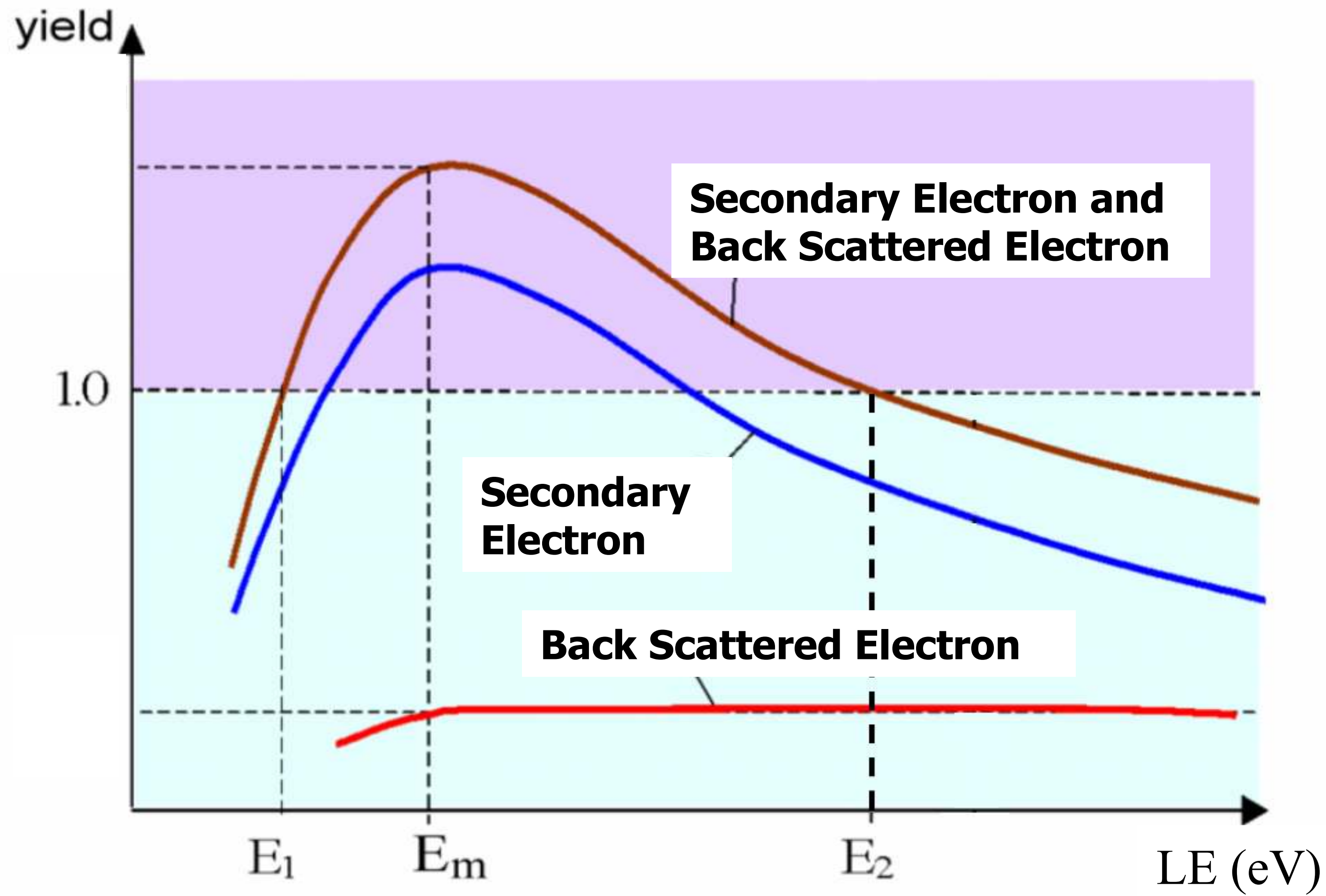
Illustration of eScan®300





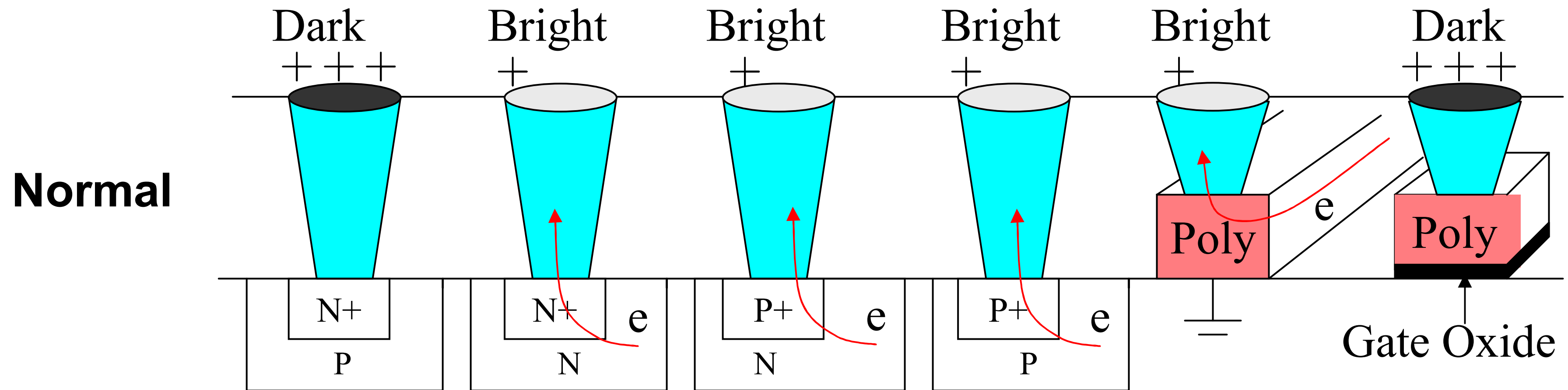


Positive Mode



W-Plugs & VC in Positive Mode

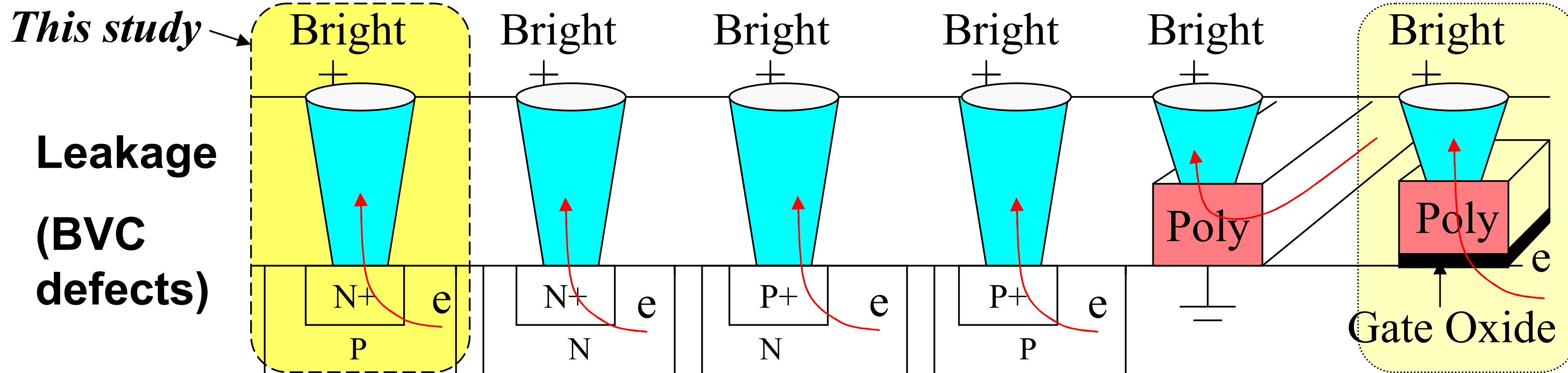
Normal



This study

Leakage

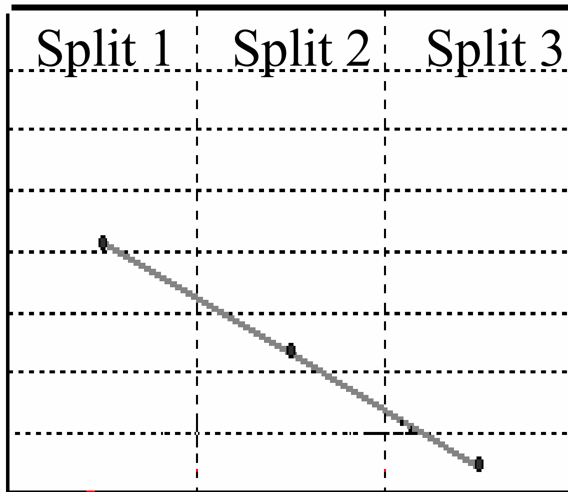
(BVC defects)

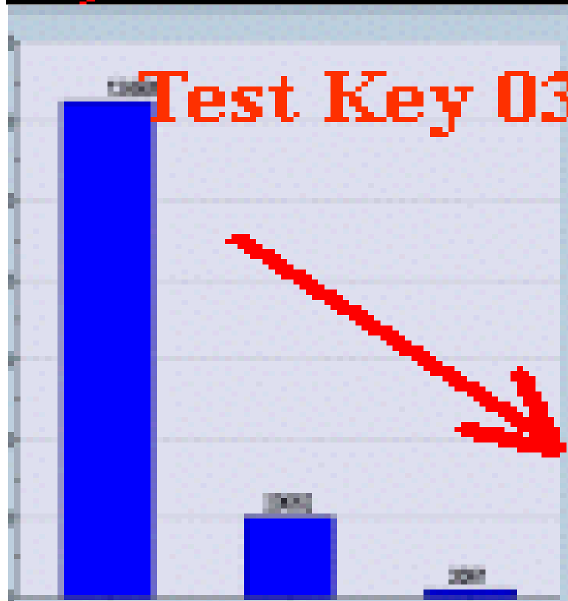


Experiment 1

- **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**

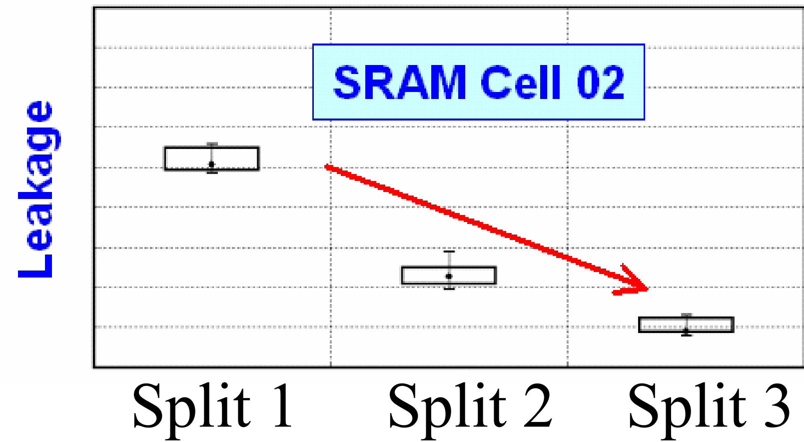
Correlation of WAT and eScan®

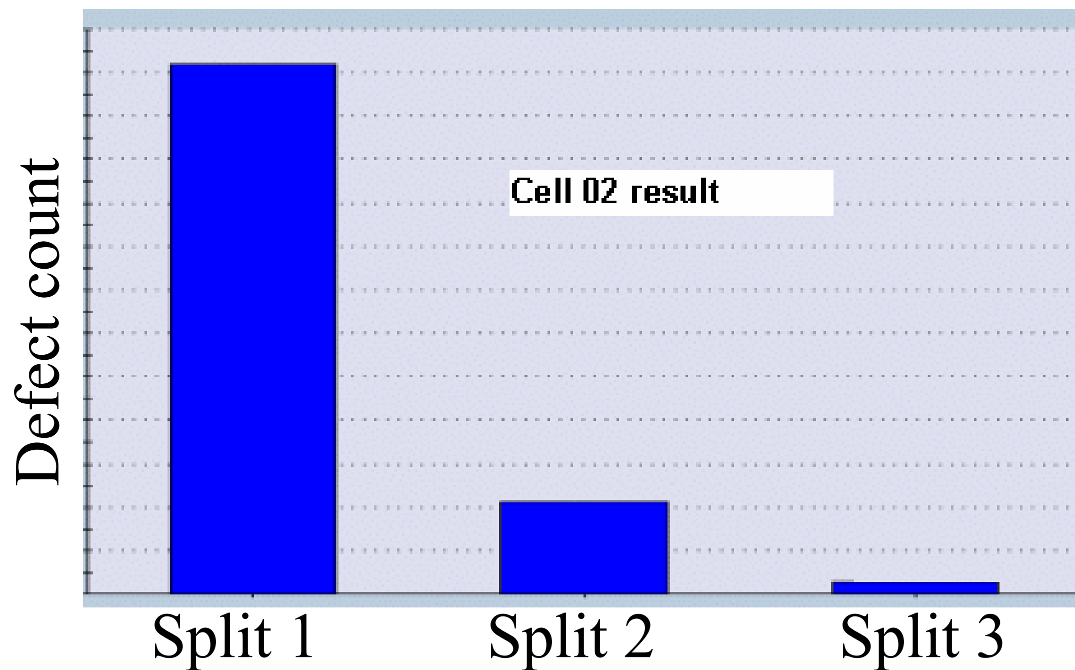




BVC Defect

Correlation of WAT and eScan®

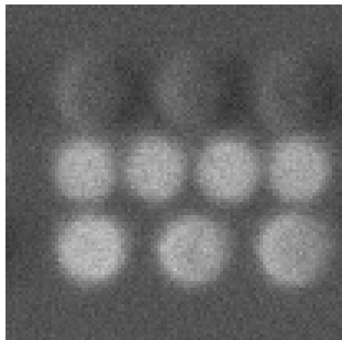




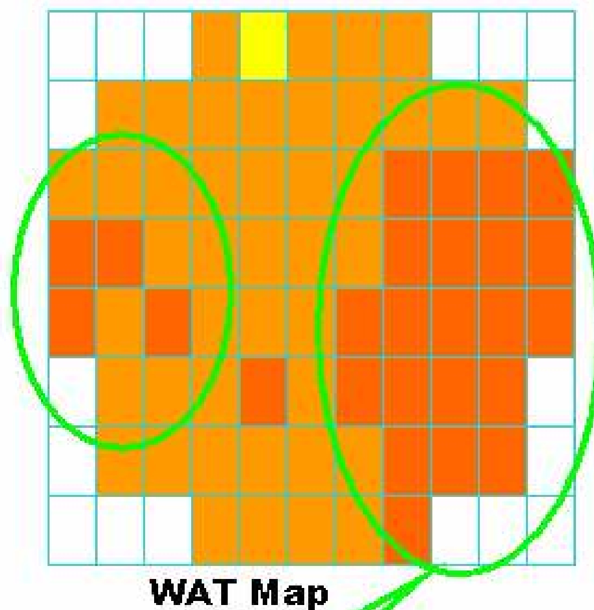
GLV Binning

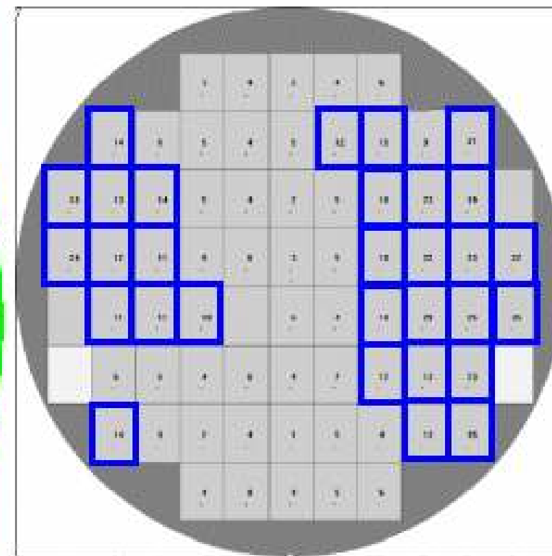
- Strong leakage causes high GLV
- Auto binning GLV of all BVC defects
- High GLV BVC map matches with high leakage current map very well.

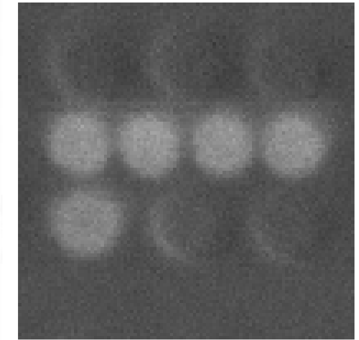
WAT Leakage Map and eScan BVC Map



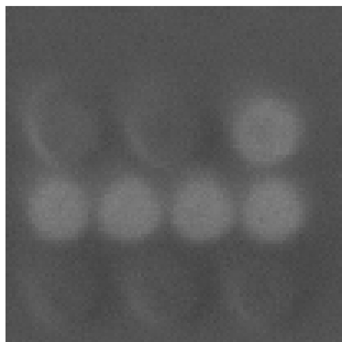
GLV1







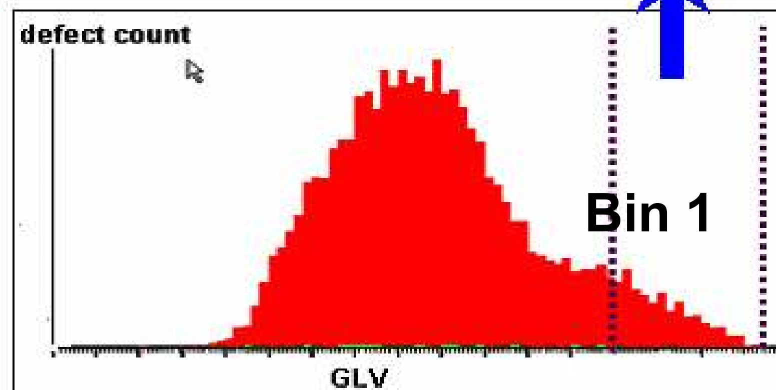
GLV2

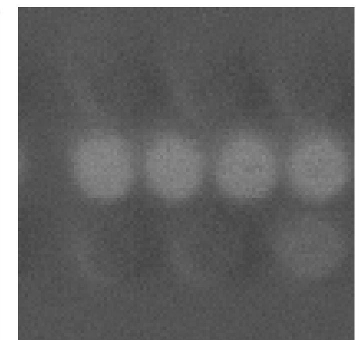


GLV3

Higher N+/P-well leakage

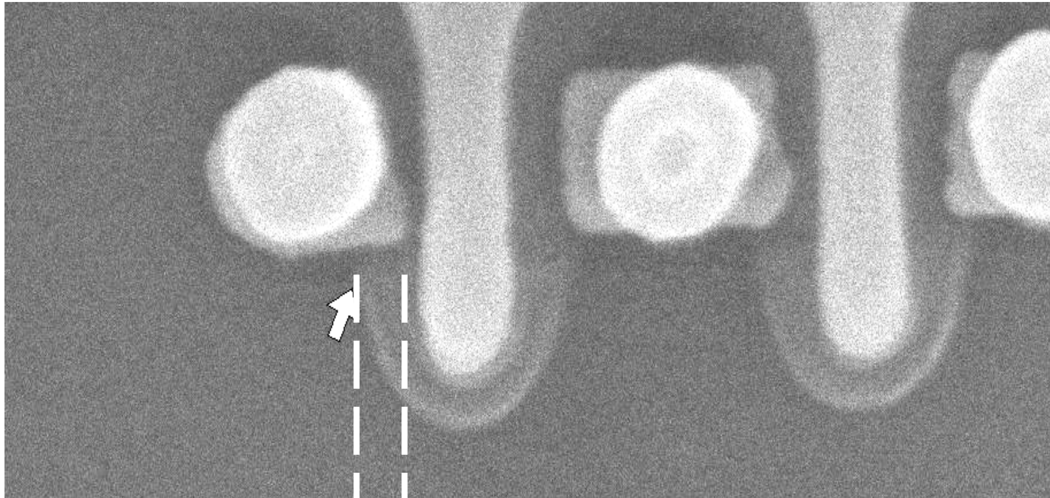
High Gray Level / High Correlation



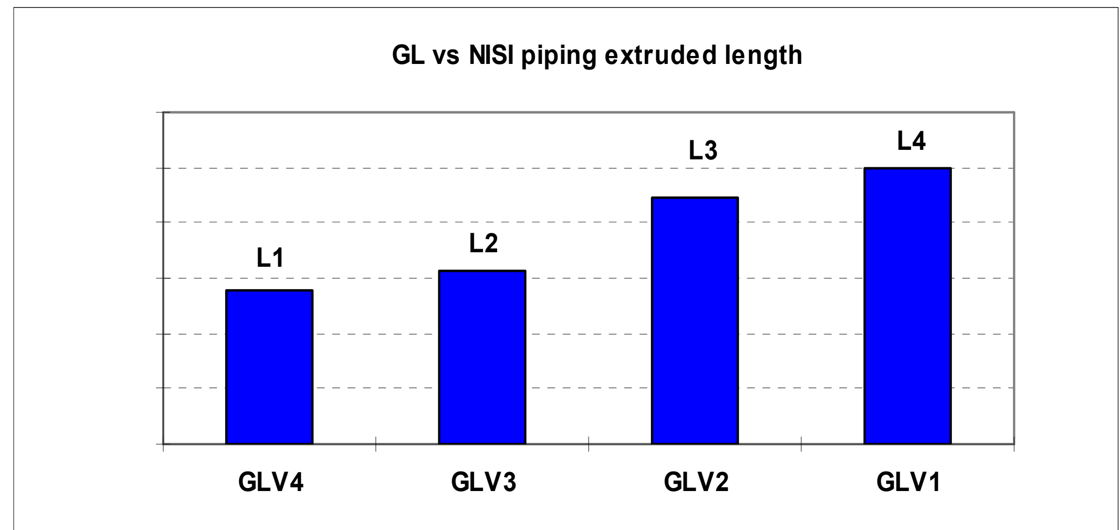


GLV4

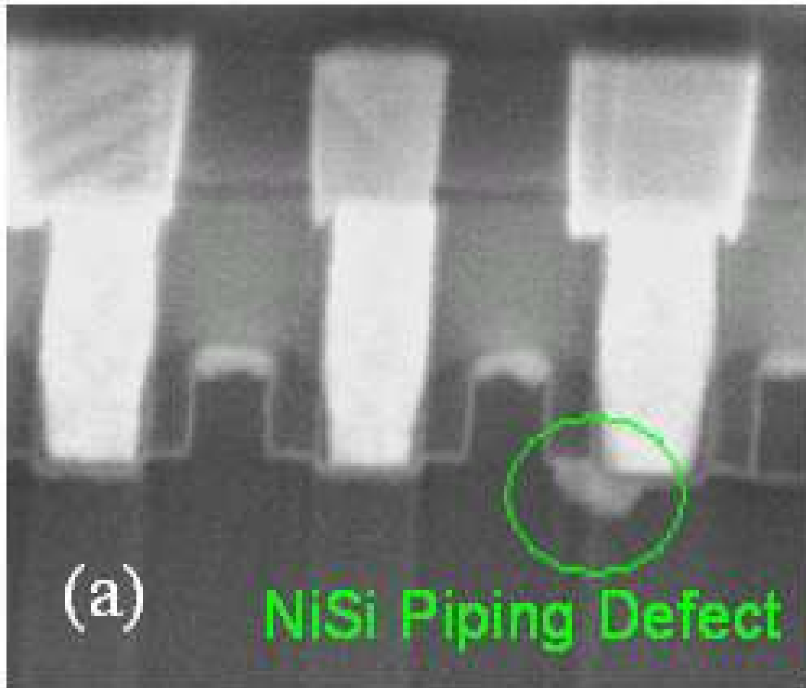
Extrusion Length vs eScan GLV

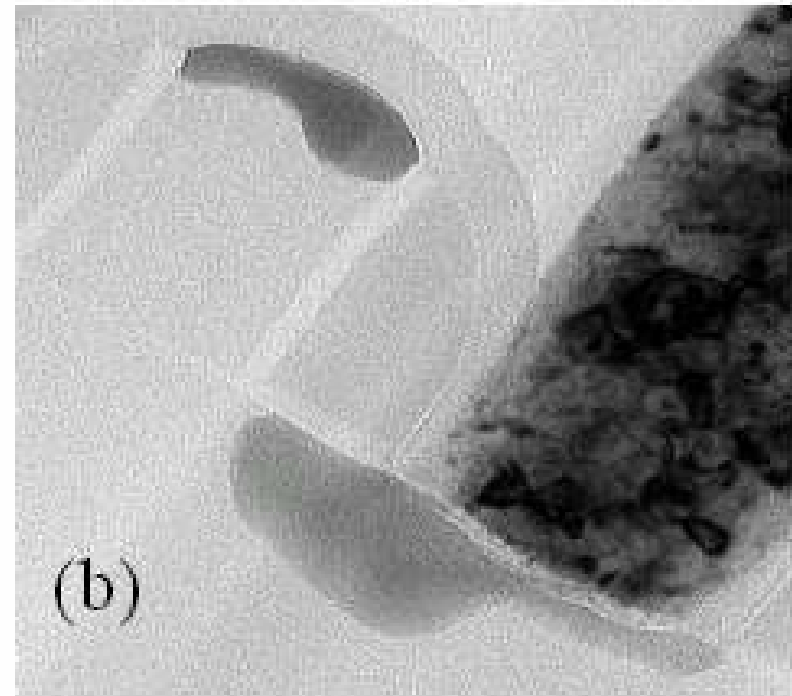


Extrusion length



NiSi Diffusion





SEM **TEM**

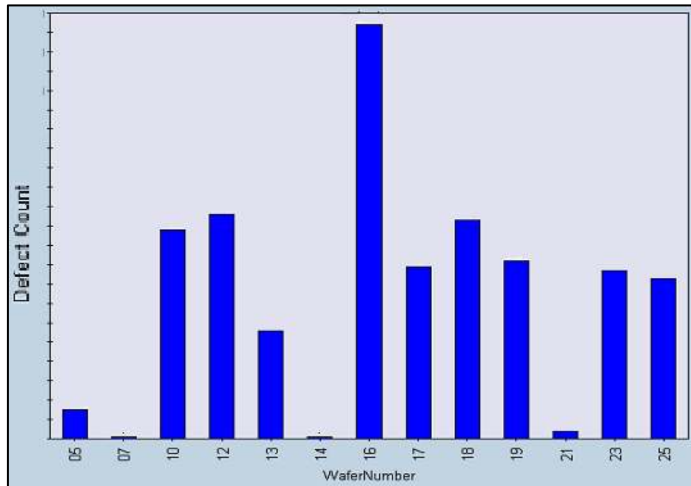
Leakage is caused by NiSi diffusion

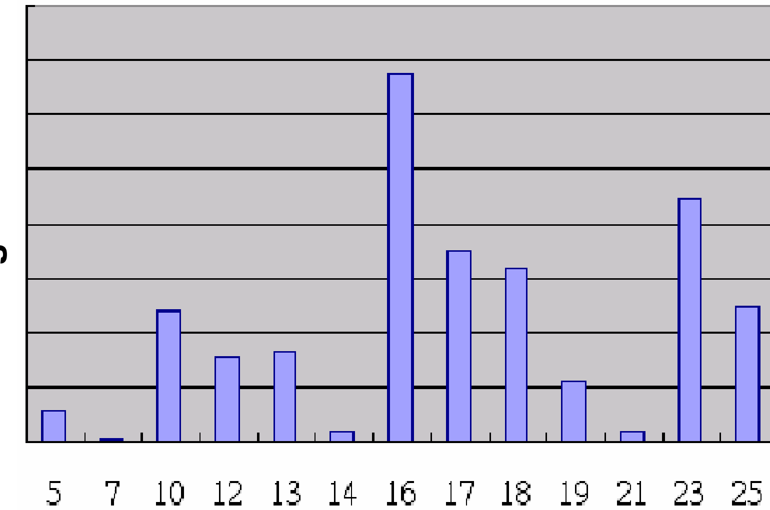
Experiment 2

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

BVC counts vs. WAT Leakage

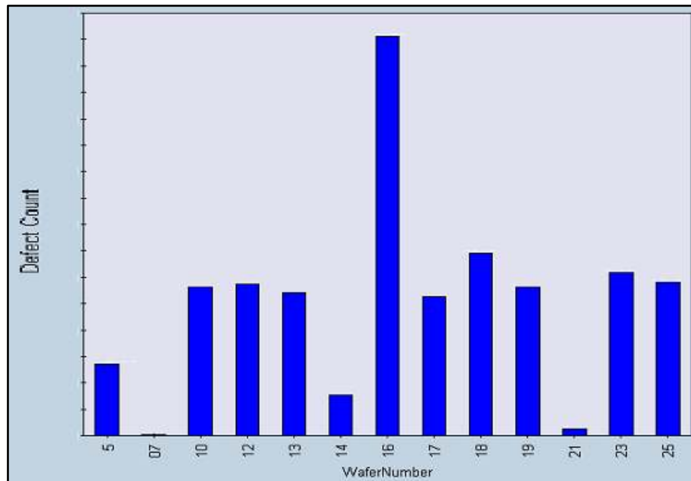
Test key 1

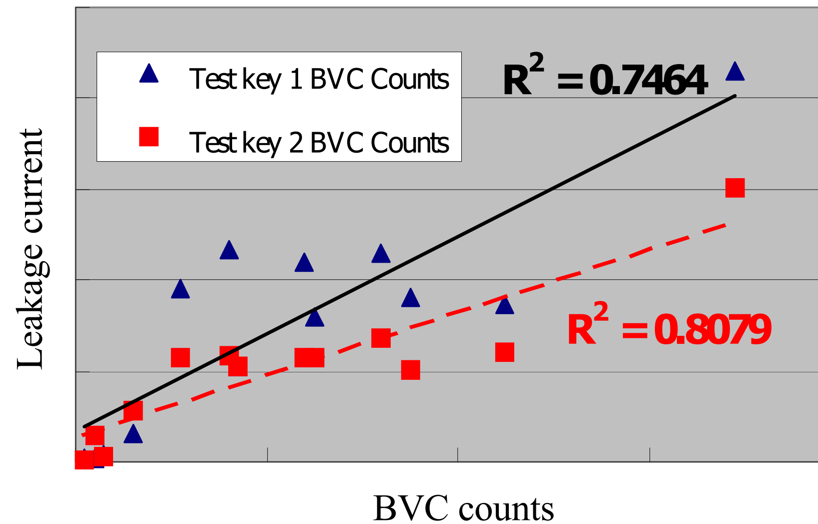




WAT

Test key 2





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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.