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A Comparison of Wafer Retest Methods: In-Situ vs. Post-sort Selective

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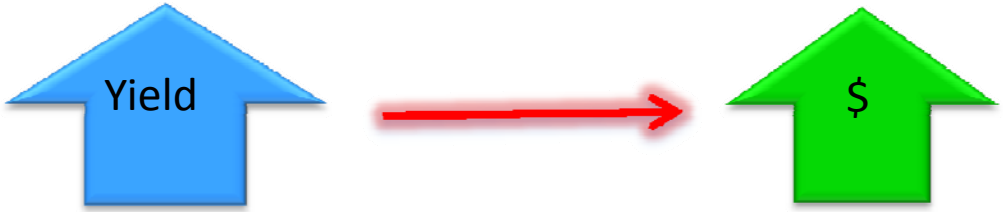
Agenda

- What is Wafer Retest, and Why do We do It?
- What are the Types of Wafer Retest?
- Wafer Retest Attributes
- Software Issues Involving Retest
- Results from Altera Wafer Retest Data
- Cost Savings Potential
- Retest Yield Distribution
- Rule Based Retest
- Summary

What is Wafer Retest, and Why do We do it?

- The semiconductor business is driven by yield:

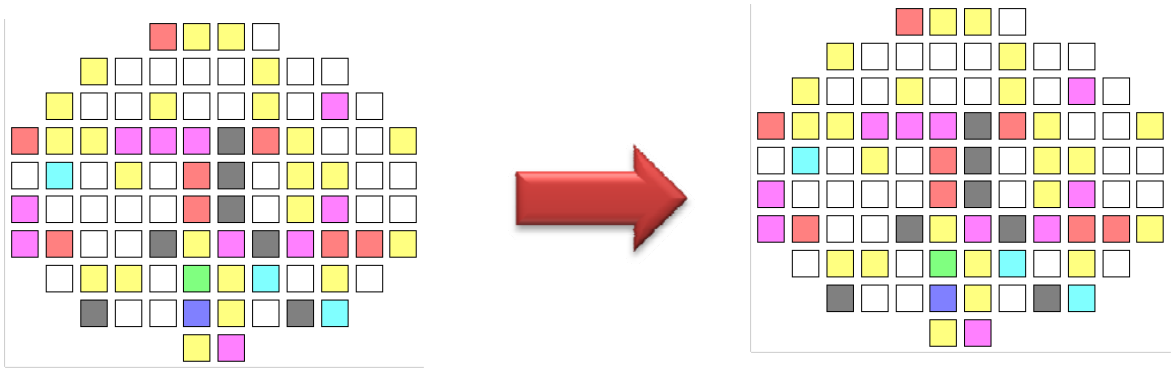


- Testing doesn't always yield the expected amount on the first pass.

- To reclaim possible false failures, wafers may be retested.
  - False Failure: Dice which fail on the first test, but pass on subsequent retest(s). Can be caused by test hardware, test program, wafer / probe contamination, etc.
- The result is money is reclaimed from the scrap bin.

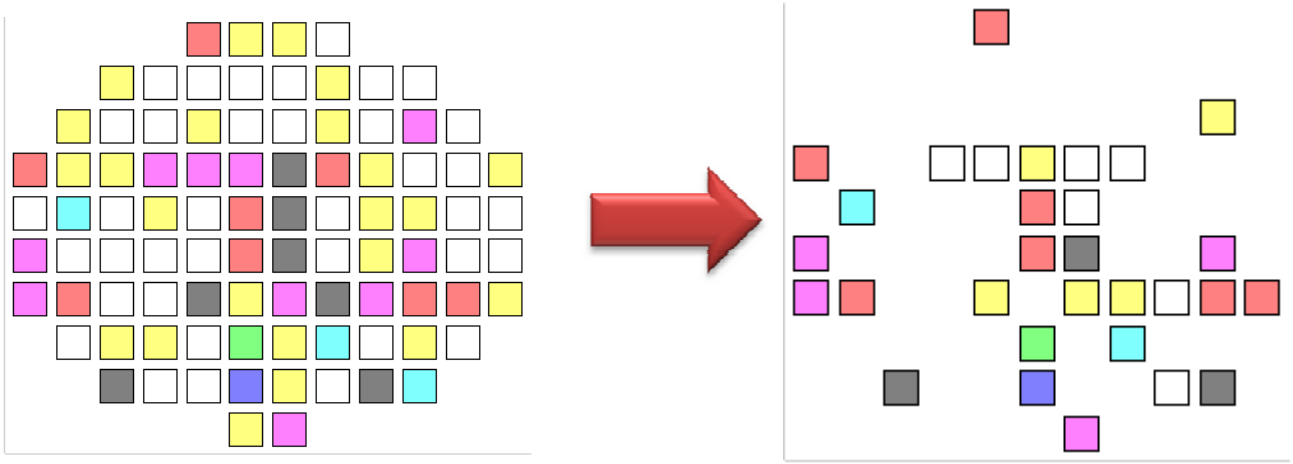
What are the Types of Wafer Retest?

- Whole Wafer Retest



Whole Wafer: Retest every die after complete lot has finished test

- In-situ and Selective Wafer Retest



In-situ: Retest only specific dice immediately after whole wafer test

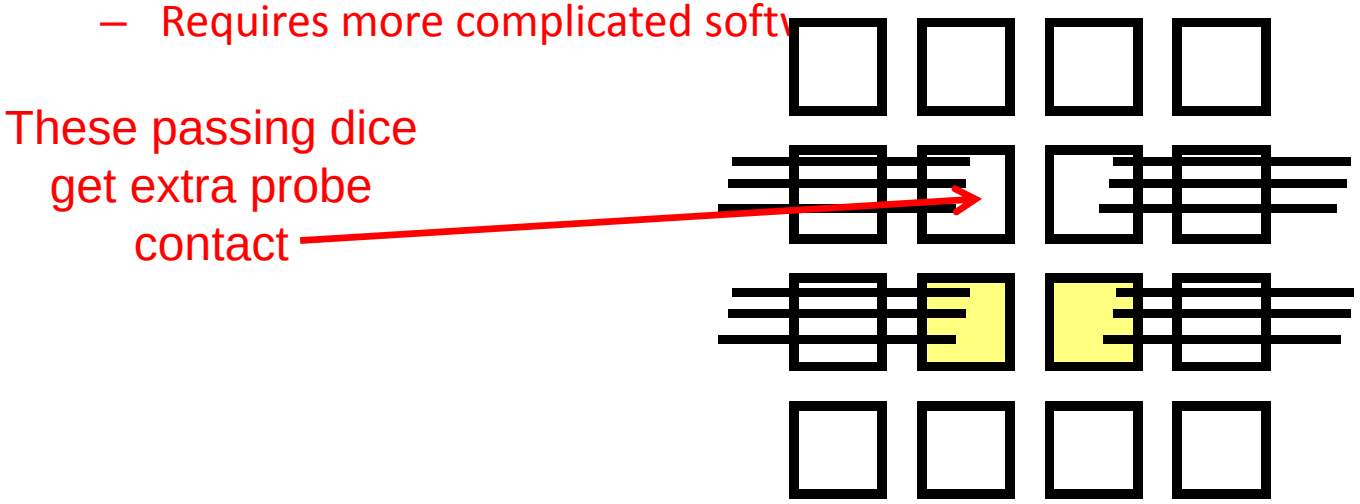
Selective: Retest only specific dice after lot has finished test

Wafer Retest Attributes

- Whole Wafer:
  - Verifies all dice. May eliminate false passes and false fails due to test program issues, setup error, hardware problems
  - No additional test software – just retest the wafer and nullify past results
  - Increases chance for bond pad damage
  - Increases sort cycle time

Wafer Retest Attributes (continued)

- In-situ:
  - Only retests failing dice (or specified dice based on whole wafer binning) immediately upon whole wafer completion
  - Saves on setup time, reduces setup error frequency, catches most of the false failures
  - May not catch gross failures due to initial setup errors.
  - May subject passing dice in multi-site probing setup to more probe damage
  - Requires more complicated soft



Wafer Retest Attributes (continued)

- Selective:
  - More likely to catch gross failures due to setup.
  - Single site probe card less likely to cause damage to adjacent dice
  - Effective for testing dice at non-yielding steps
  - Increases number of setups, may increase setup errors
  - May increase test cost
  - Increase in test time – tester controlled prober indexing
  - Possible increase in cycle time
  - Requires more complicated test software

Software Issues Involving Retest

- In-Situ: Matching summaries. Total die qty passing on retest needs to be added to original passing die total, but total tested shouldn't be incremented.

	W1F	W1I	W2F	W2I	W3F	W3I	Grand Total
Total Tested	XXX	65	XXX	70	XXX	48	XXXX
Total Passed	YYY	3	YYY	2	YYY	0	YYYY
Total Failed	65	62	70	68	48	48	361

Grand Total Tested = only sum of "F" Totals

Grand Total Passed= Sum of all Passing

Why? Need to keep accurate yield data!

Yield based on Total Passed / Total Tested (Full Wafer Dice)

Software Issues Involving Retest (continued)

- Selective: Summary data must be downloaded from server to tester so only specified failure dice are re-tested

Full Sort Summary

	W1 FS	W2 FS	W3 FS	Grand Total
Total Tested	XXX	XXX	XXX	XXX
Total Passed	YYY	YYY	YYY	YYY
Total Failed	46	63	44	153

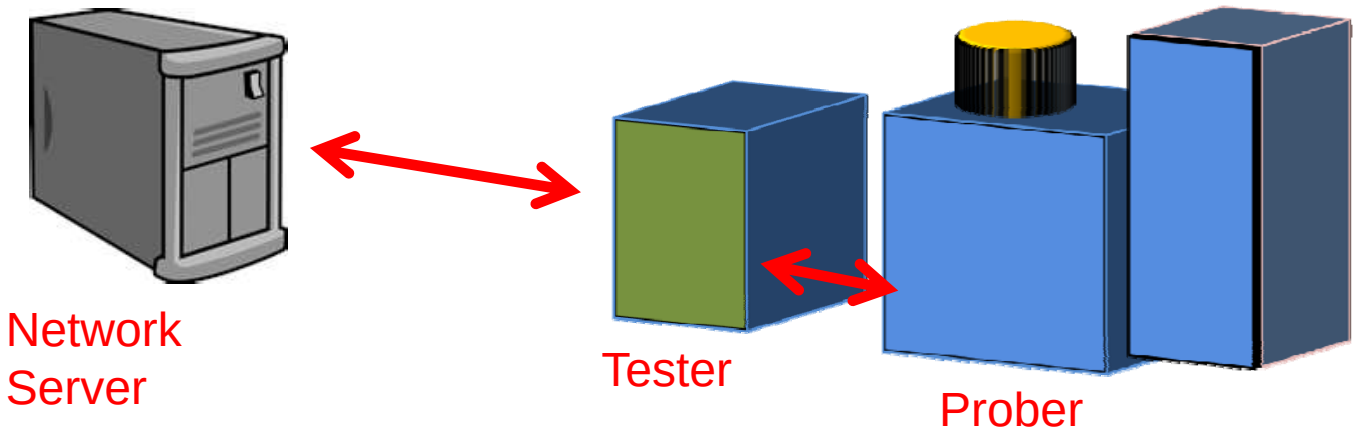
Selective Retest Summary

	W1 SR	W2 SR	W3 SR	Grand Total
Total Tested	46	63	44	153
Total Passed	5	25	10	40
Total Failed	41	38	34	113

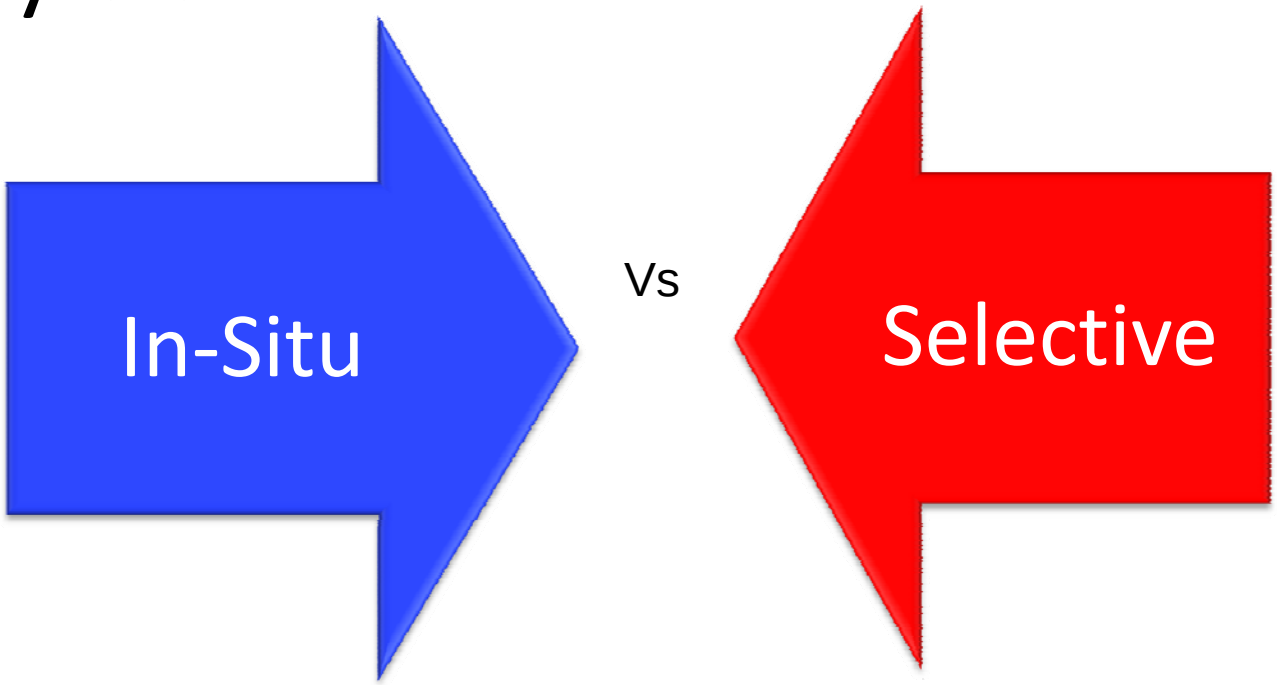
Final Yield =
(Total Passed Full + Total Passed Selective) /
Total Tested Full

Software Issues Involving Retest (continued)

- Wafer OCR / Barcode reader must be used - prevent wrong wafer associated with Retest data
- Tester must gather summary data from network so it can direct prober to re-test die locations.



Which retest method provides the best compromise between efficiency and yield?

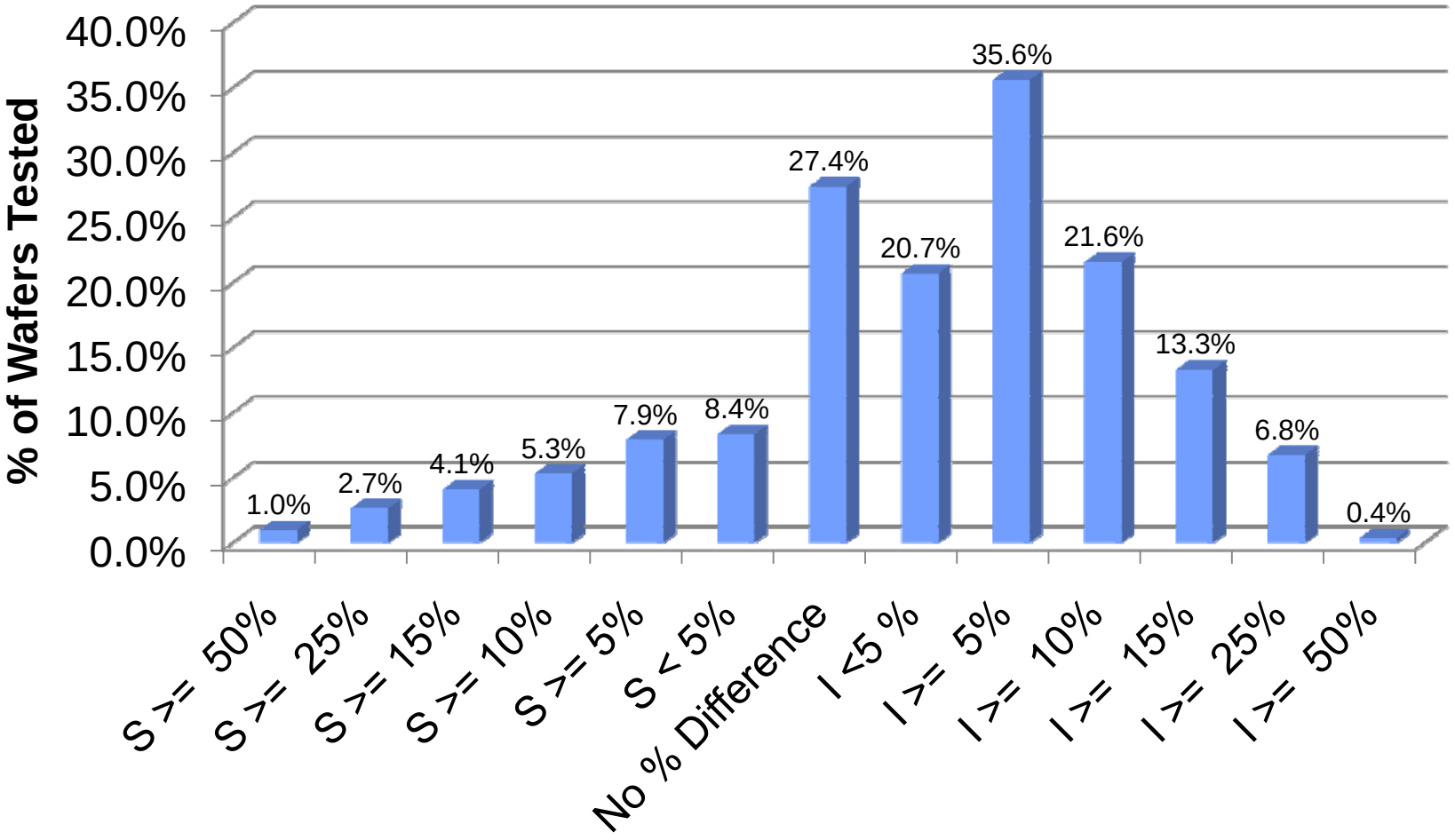


Results from Altera Wafer Sort Data

	Total Wafers	Avg Retest Recovery Yield
Total Unique Wafers:	9428	-
# In-situ Recovery "Winners"	5439	9.0%
# Selective Recovery "Winners"	1091	4.6%
No Die Difference	2898	-

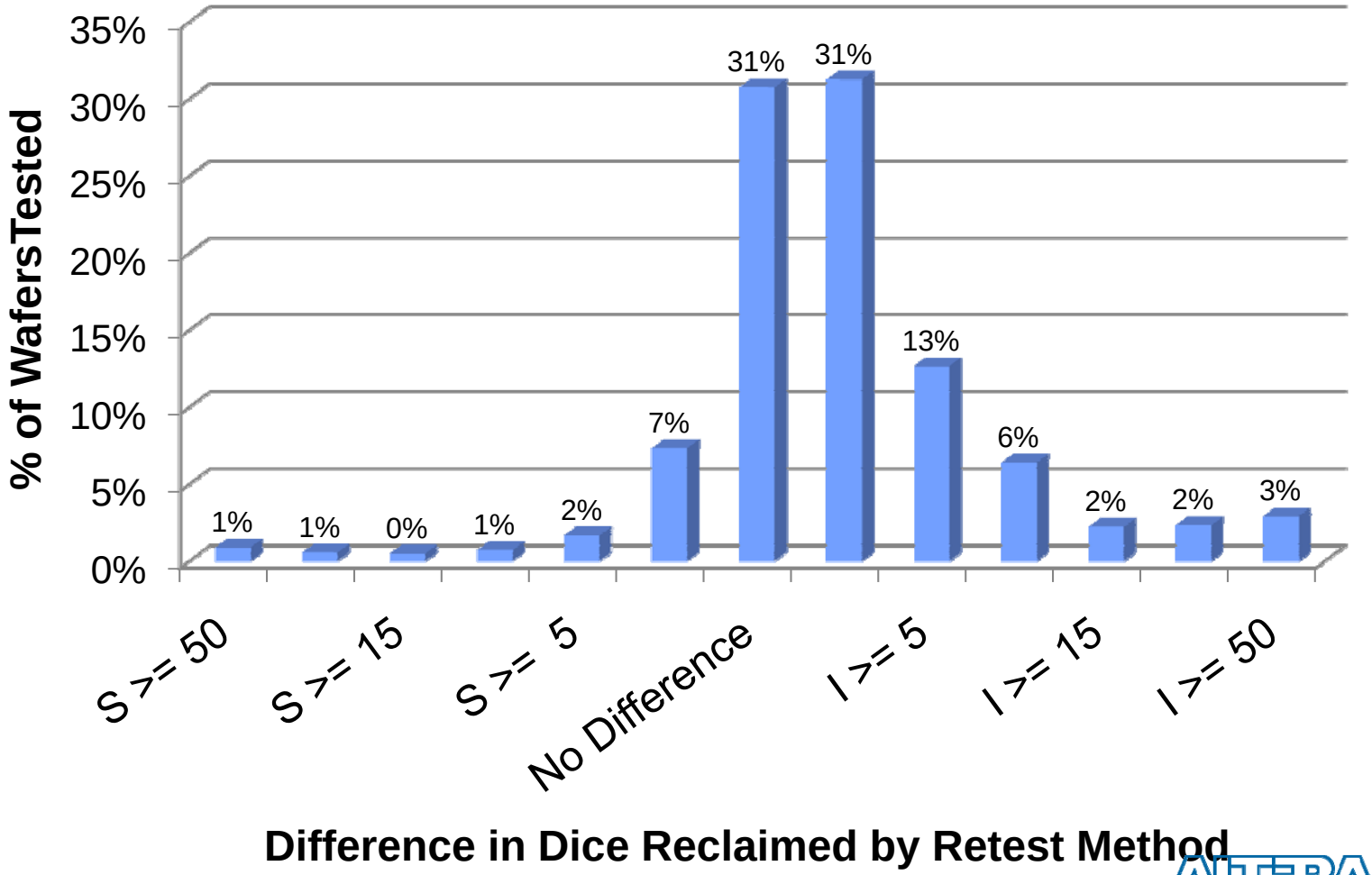
Over 6 Million Dice Tested

In-Situ vs. Selective Retest : Difference of Die Yield Reclaimed



% Reclaim Yield Difference by Retest Method

In-Situ vs. Selective Retest : Difference of Die Yield Reclaimed



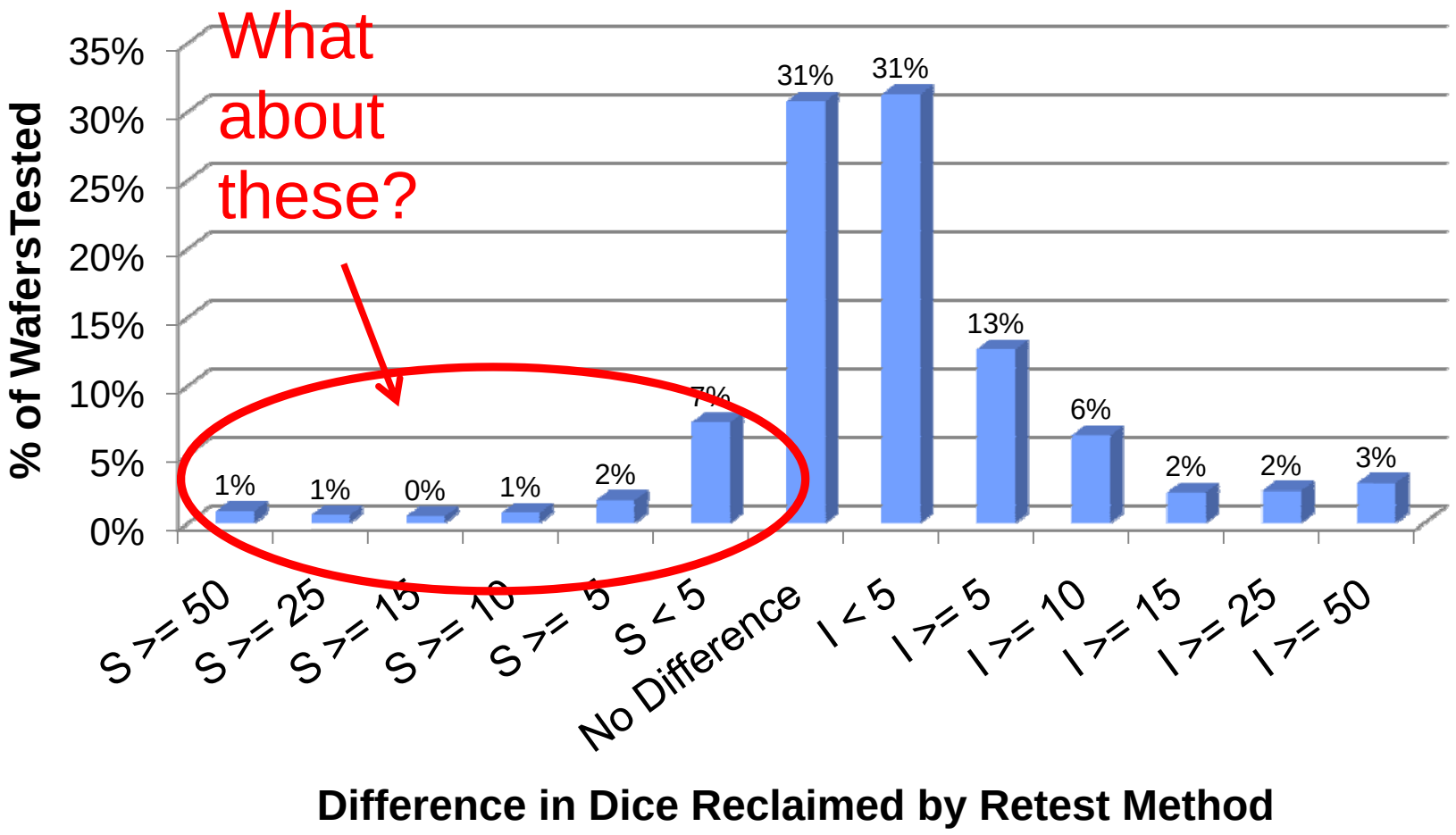
In-Situ vs. Selective Retest :

- So, looks like the winner is In-situ…
- Upon “further review…”
  - It’s not necessarily the Retest method recovery difference, it’s the amount of dice actually recovered because of the Retest…

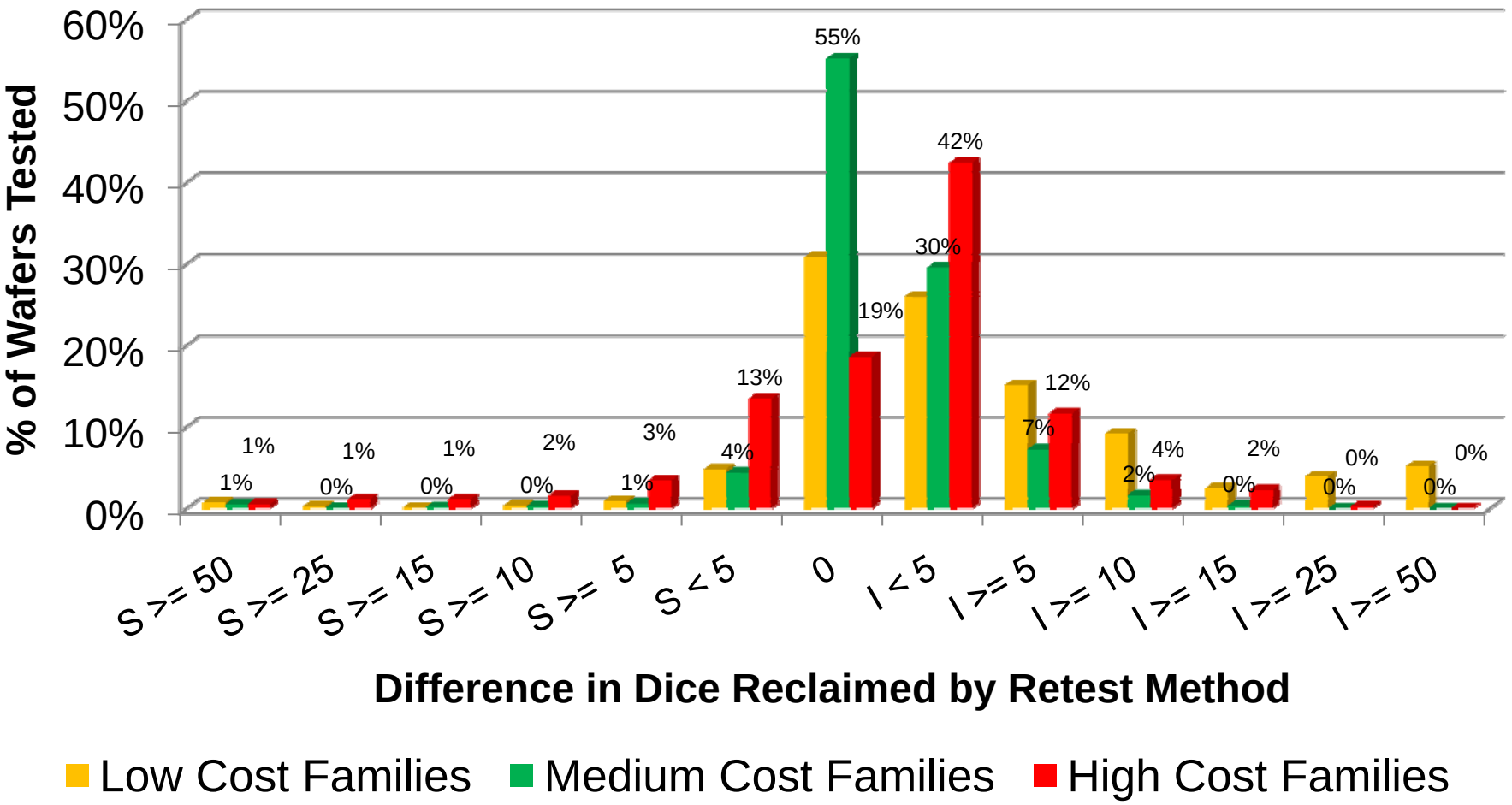
In-Situ vs. Selective Retest :

	Total Wafers	Avg Retest Recovery Yield	Additional Recovery Dice
Total Unique Wafers:	9428	-	-
# In-situ Recovery "Winners"	5439	9.0%	50,014
# Selective Recovery "Winners"	1091	4.6%	21,199
No Die Difference	2898	-	-

In-Situ vs. Selective Retest : Difference of Die Yield Reclaimed



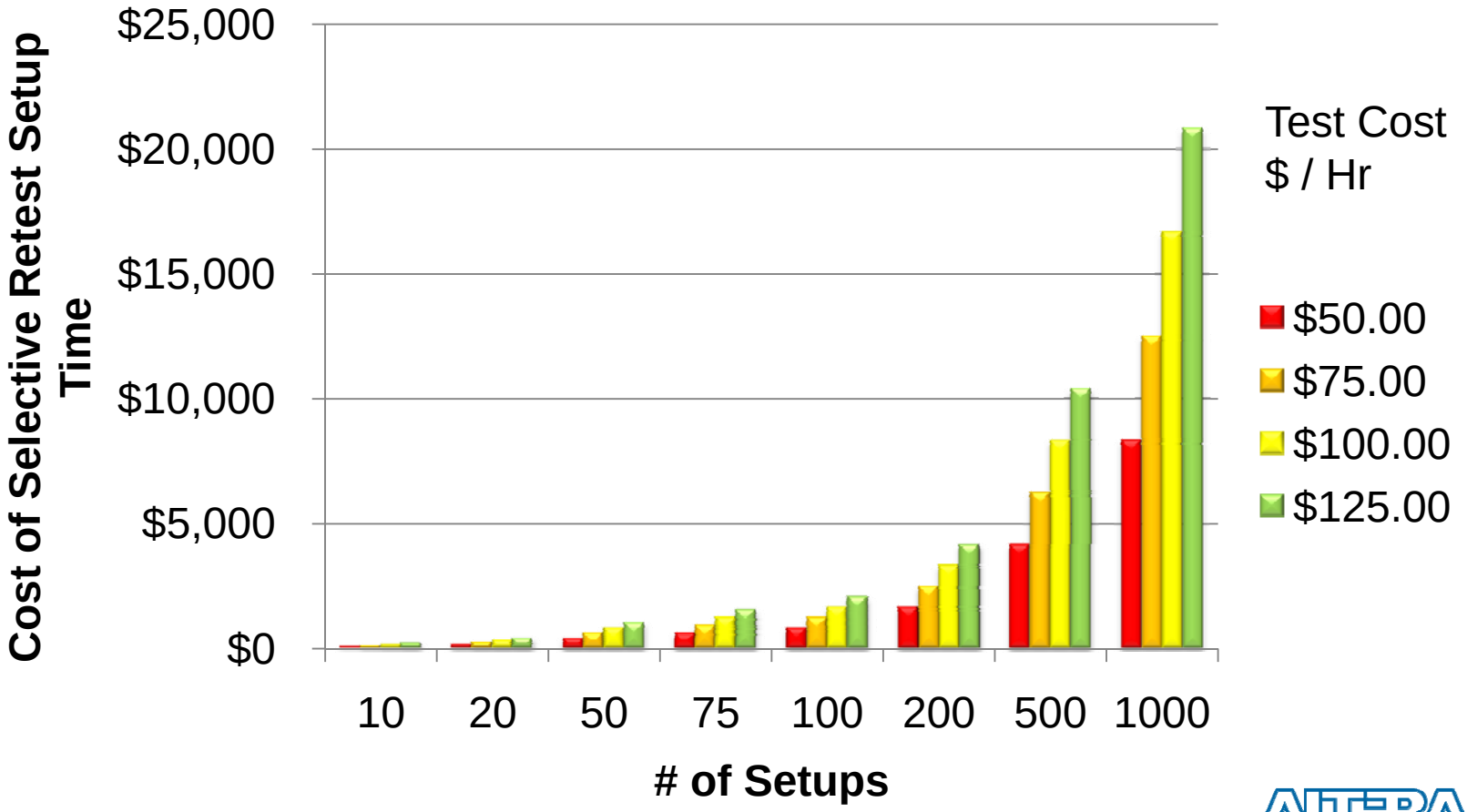
In-Situ vs. Selective Retest : Difference of Die Yield Reclaimed – by Product Family



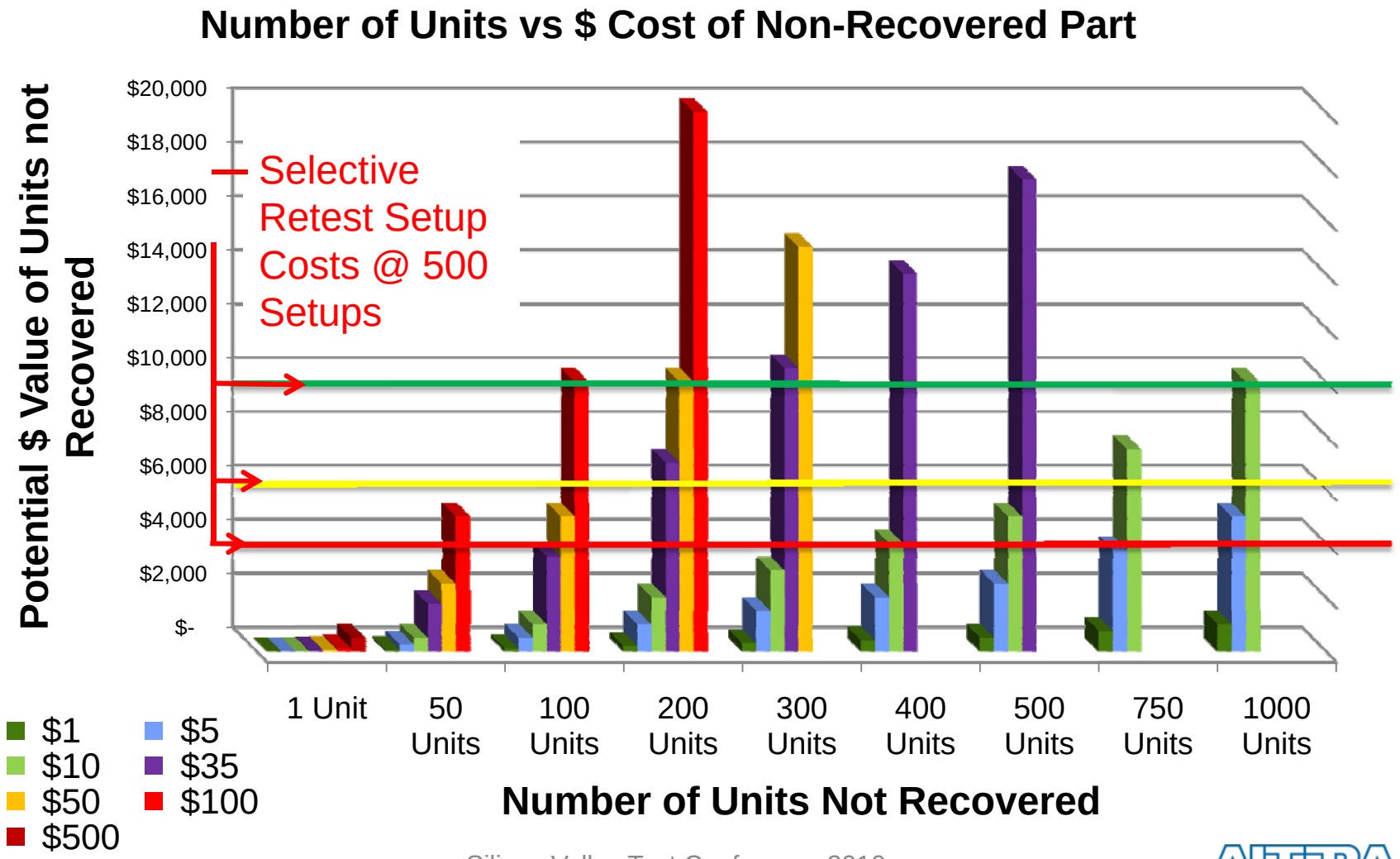
Cost Savings Potential

- Possible savings may accrue if the test cost model charges extra for selective retest setup time.

Cost of Setup Time vs # of Setups with 10 minute Average Setup Time

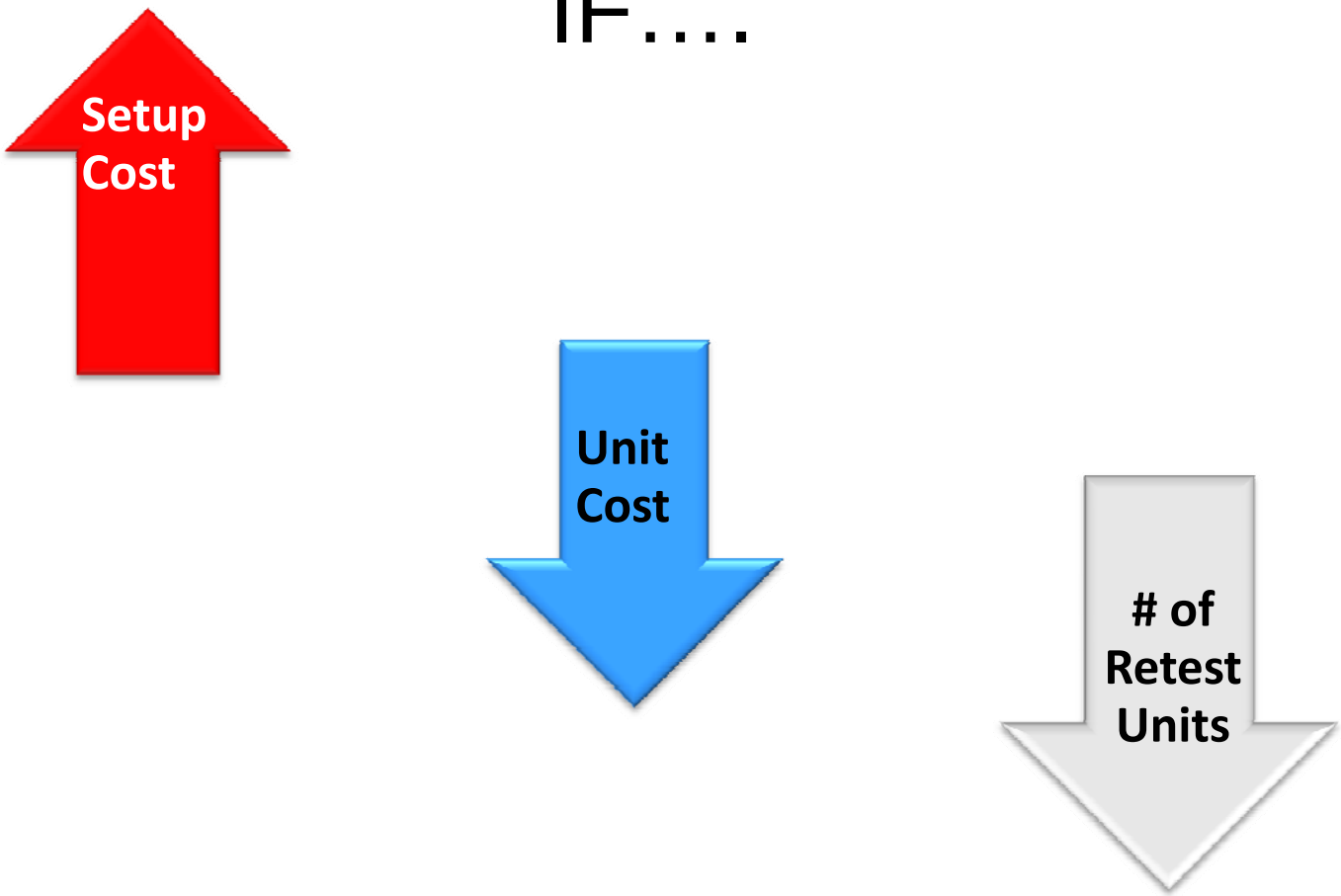


Cost of Setup Time vs # of Setups with 10 minute Average Setup Time



Cost Savings Potential with In-Situ Retest

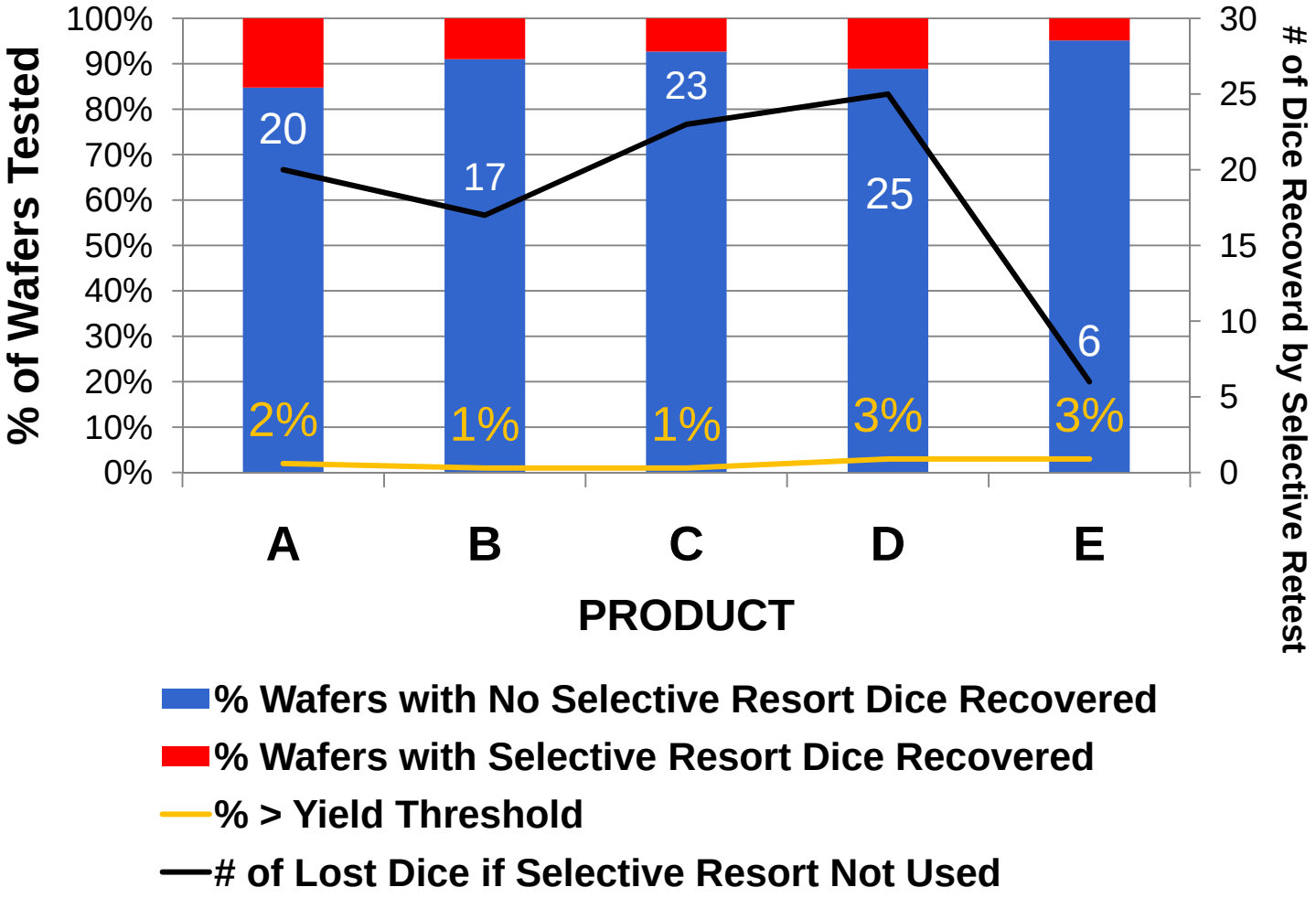
IF….



Cost Savings Potential with In-Situ Retest

- The results favored in-situ Retest on average when average yield from first initial test was greater than certain yield thresholds, but selective sort proved necessary when problematic test setup conditions occurred.

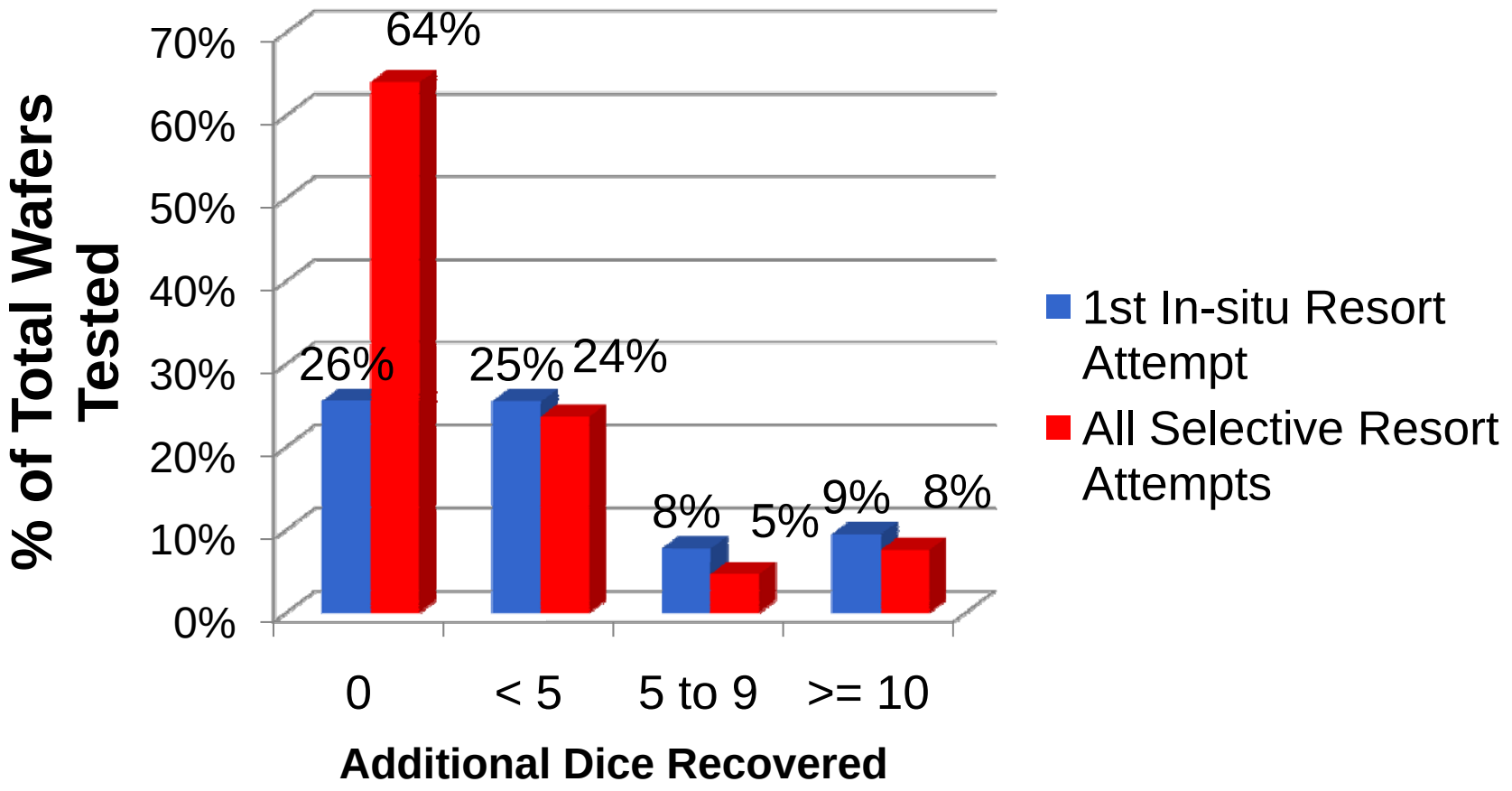
In-Situ Recovery Rate vs Increase over Yield Threshold



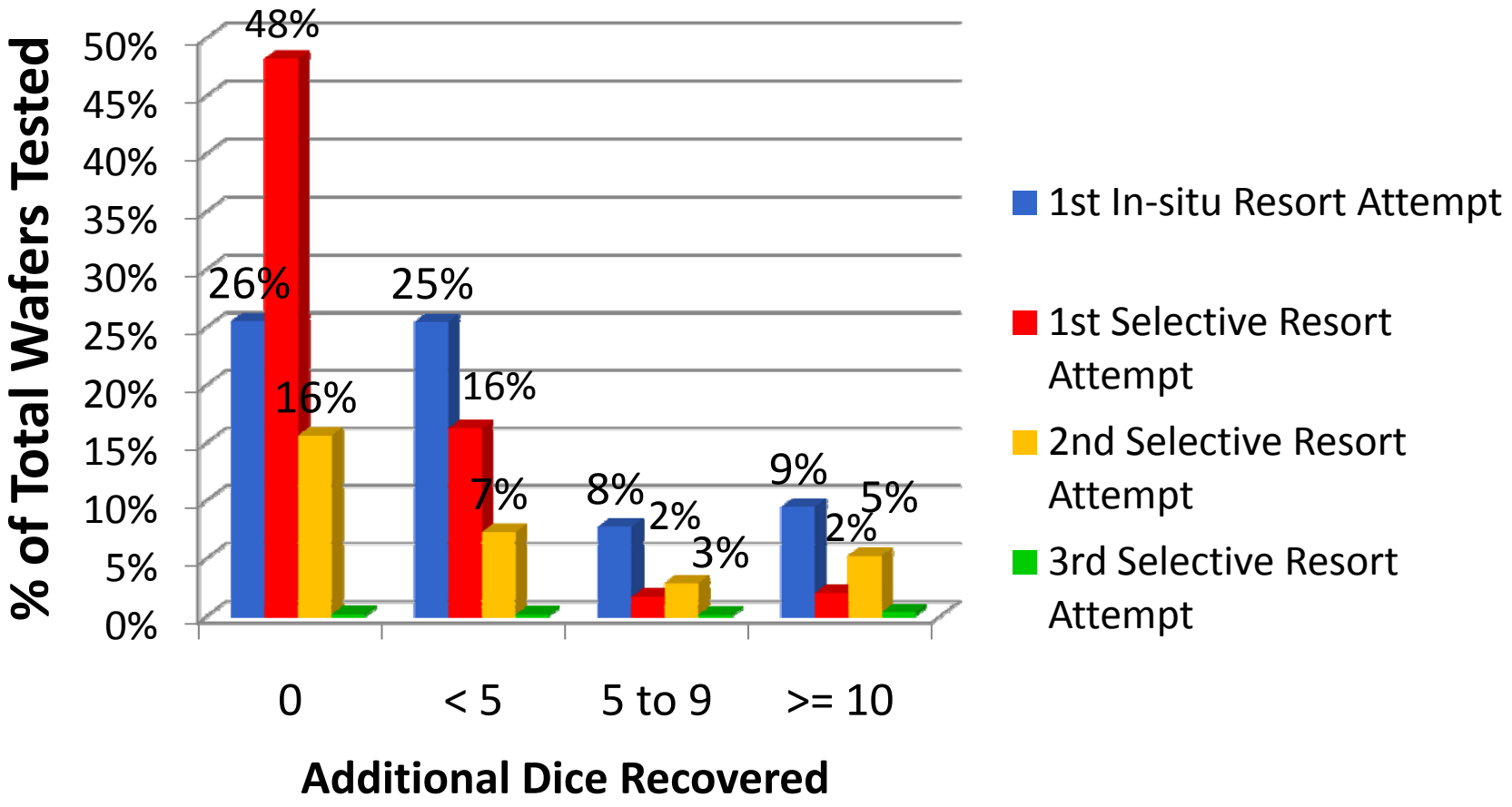
Retest Yield Distribution

- Insitu Retest does in fact, on average, increase yield vs selective Retest. But the data suggest that one pass Retest may not always be enough to capture all available yield.

Distribution of Additional Dice Recovered



Distribution of Additional Dice Recovered Per Retest Attempt



Rule Based Retest

- In-Situ Retest will recover the majority of false failures. But there are cases where Selective Retest should be used.

Type of Part	Condition	Action
Any	1st Pass Yield << Std (Bad Setup)	Selective Retest
Low Cost Die	1st Pass Low Yield	In-Situ Retest
Long Test Time	Particular Failure Type	Selective Retest on Particular Failure Dice
High Cost Die	1st Pass	In-Situ Retest, then Selective Retest on Sample Wafers. If yield improvement, Selective Retest on all wafers

Summary

- Both In-Situ and Selective Retest Methods are Viable
- In-Situ will likely Recover most invalid failures, usually on the first attempt
- Rule-based Retest will likely provide the most cost effective solution

Thank you!

- Questions?