

Test in Transition: Changing Customer Requirements

Semicon 2011

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Dale Ohmart, DMTS

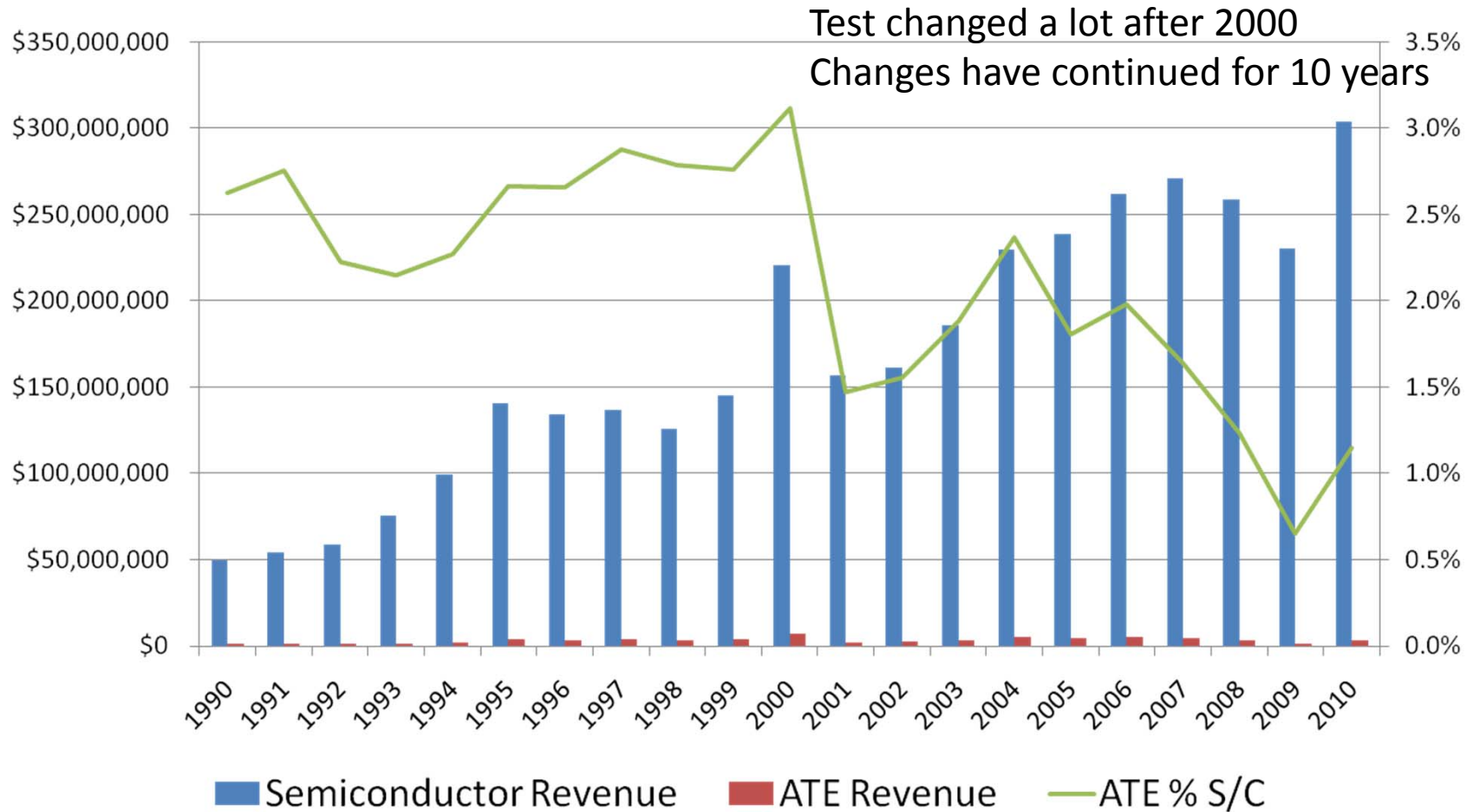
Texas Instruments

Agenda

- Industry Test Cost indices and directions
- Multisite Limitations in Non-memory
- Parts Per Hour in a real factory
- Conclusions

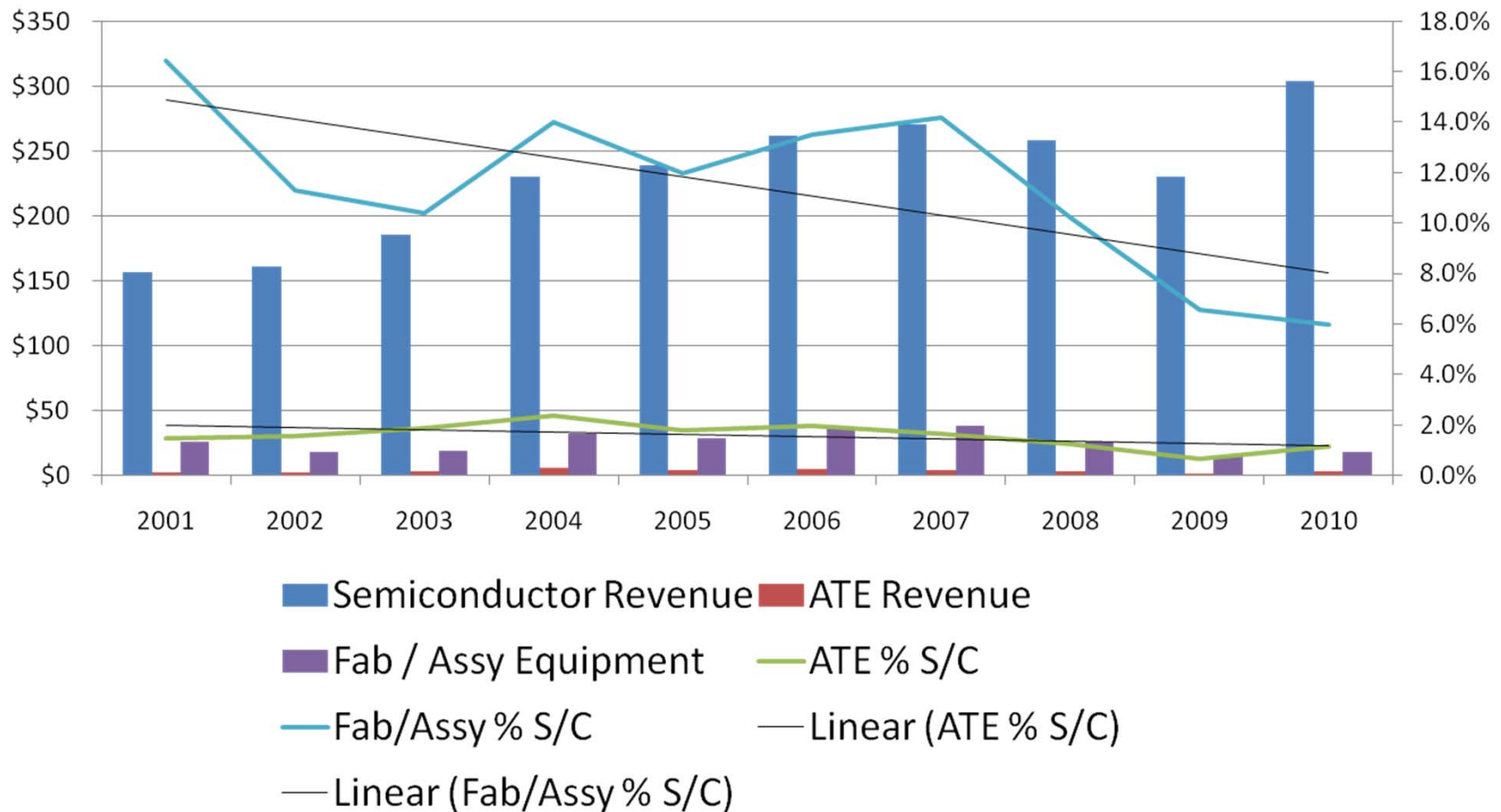
INDUSTRY TEST COST INDICES AND DIRECTIONS

Industry Semiconductor and Test



Source: Gartner, iSupply

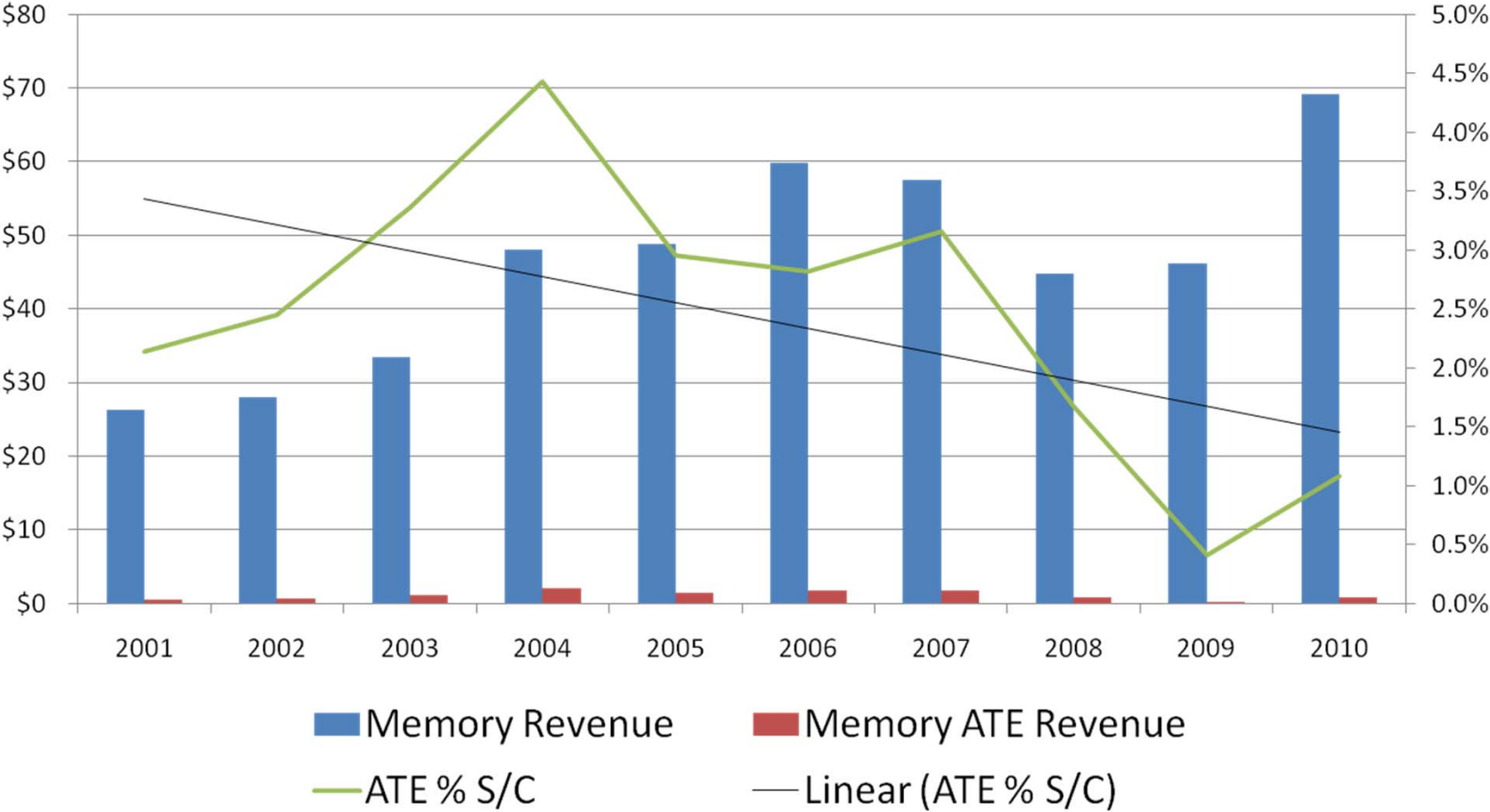
Industry Semiconductor and Equipment



Test contribution to total semiconductor manufacturing costs continues to **INCREASE**

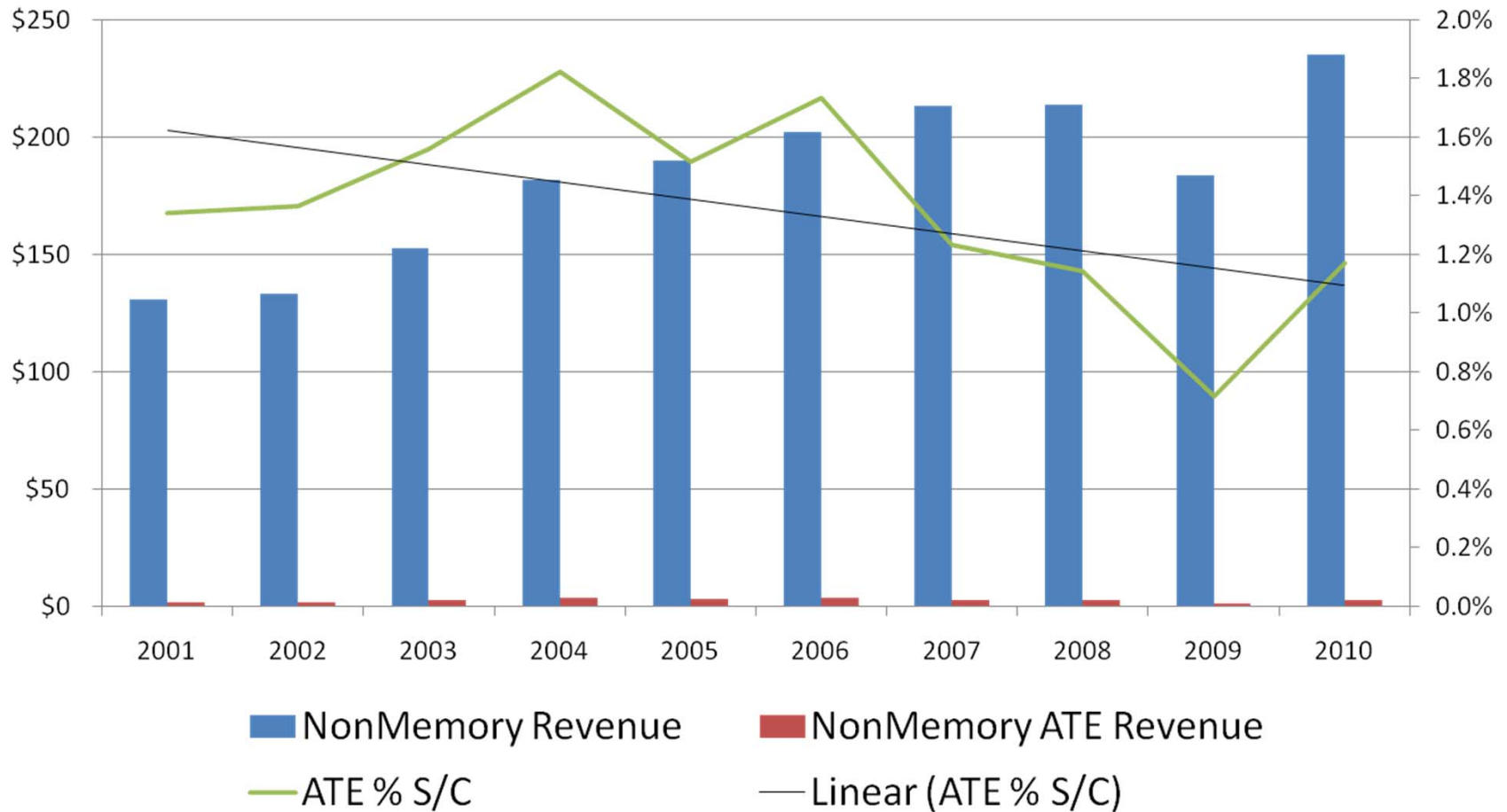
Source: Gartner, iSupply

Memory Semiconductor and Test



Memory Test cost may have decreased by 50% in the last 10 years

NonMemory Semiconductor and Test



The story for Non-Memory is not so good

% ATE Capital / SC Revenue

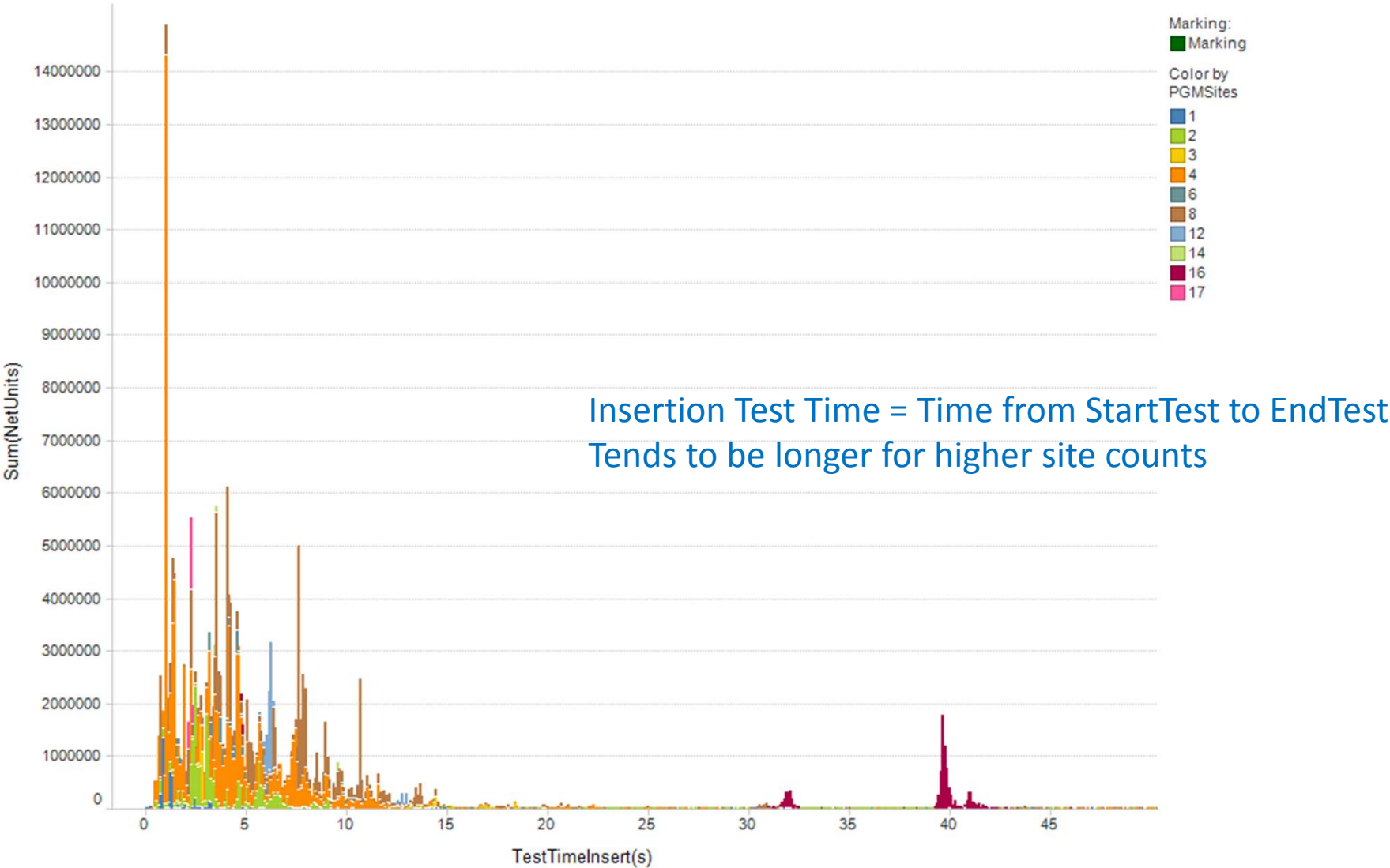


Most Test Cost improvement in the last 10 years has been in Memory

MULTISITE LIMITATIONS IN NON-MEMORY TEST

MultiSite in the NonMemory World

Bar Chart

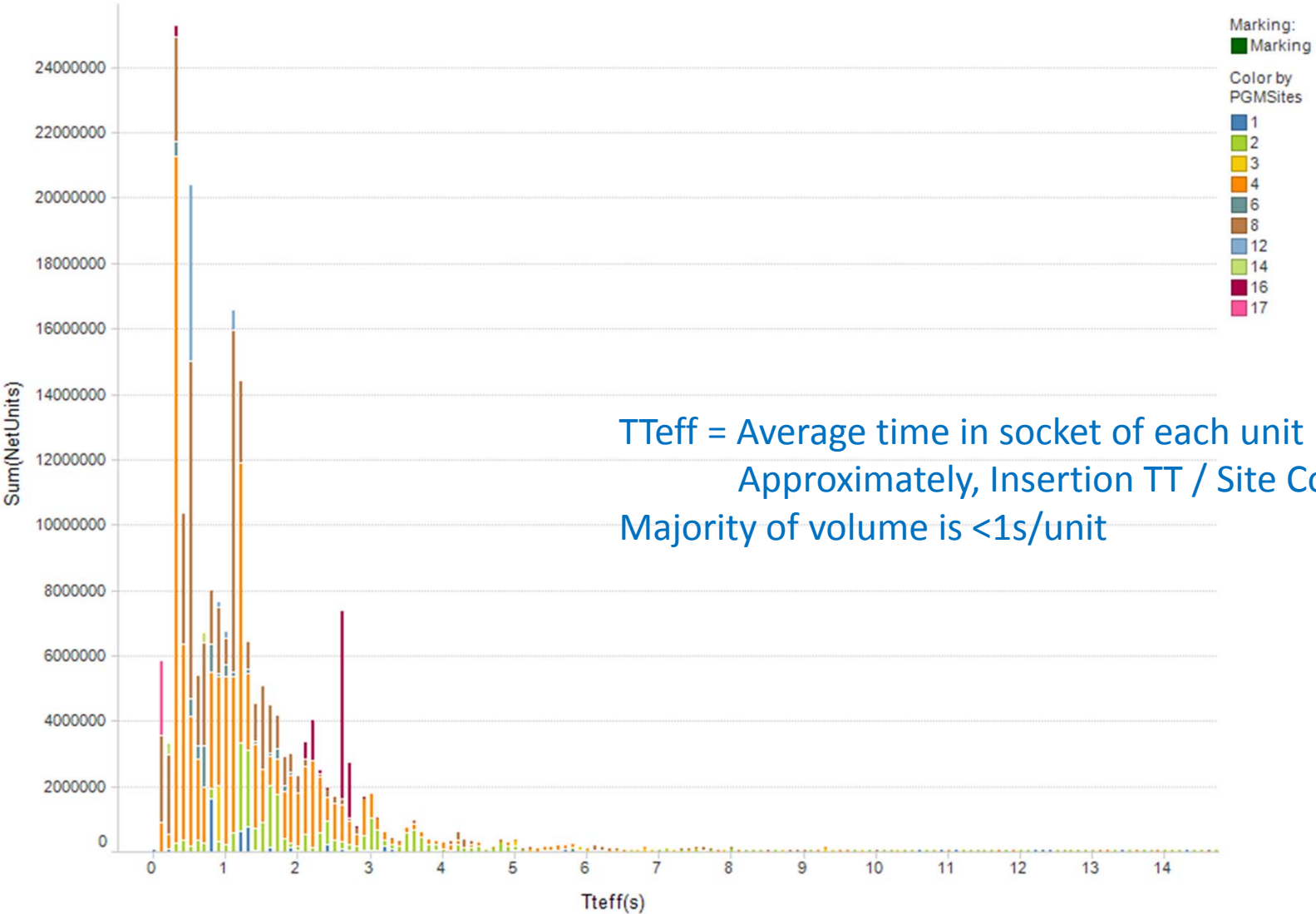


Filter Settings
- PGMSites: (1, 2, 3, 4, 6, 8, 12, 14, 16, 17)
- TestMode: (F)

Actual TI Factory Data – Analog

MultiSite in the NonMemory World

Bar Chart



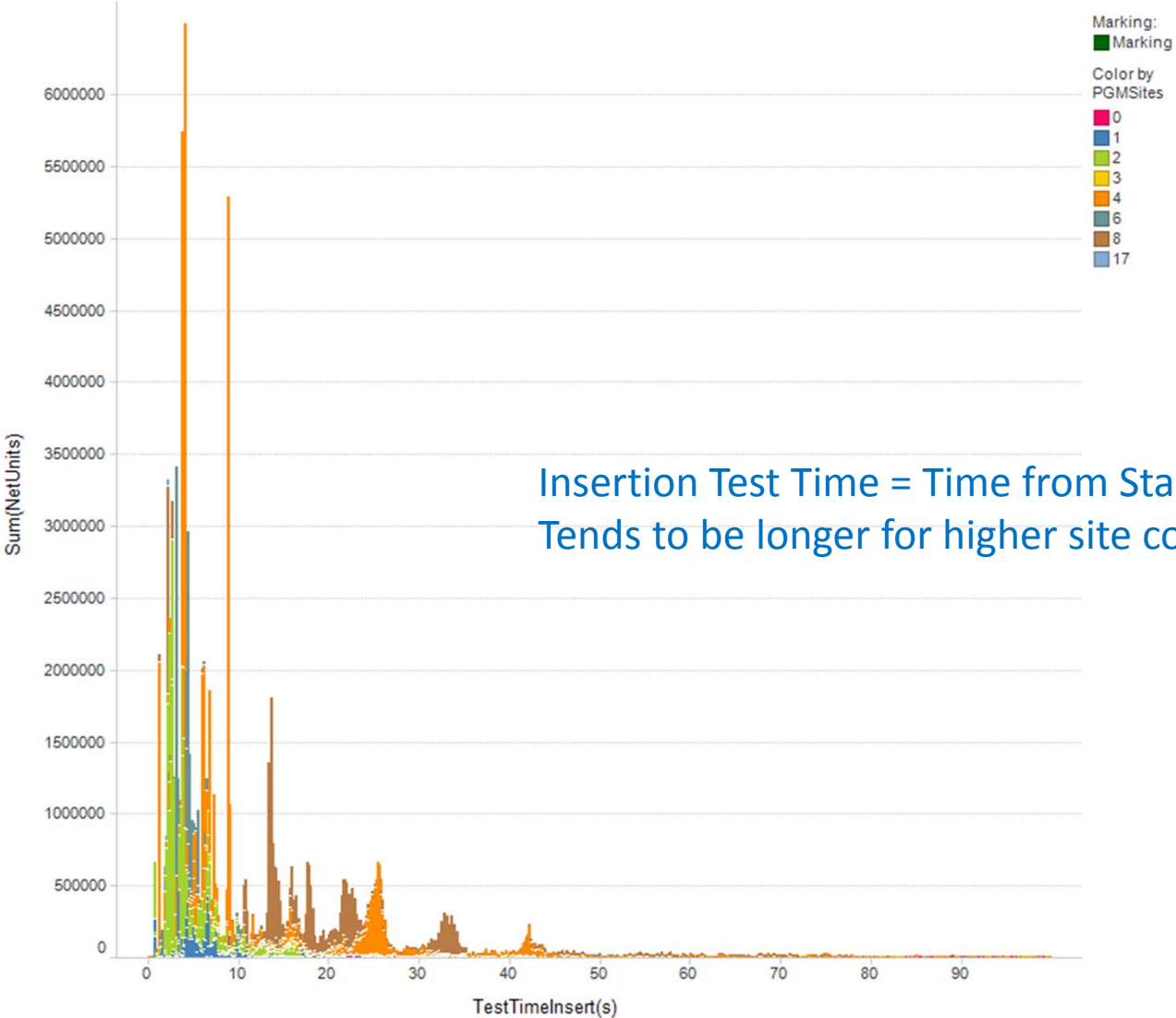
Tteff = Average time in socket of each unit
Approximately, Insertion TT / Site Count
Majority of volume is <1s/unit

Filter Settings
- PGMSites: (1, 2, 3, 4, 6, 8, 12, 14, 16, 17)
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Actual TI Factory Data – Analog

MultiSite in the NonMemory World

Bar Chart



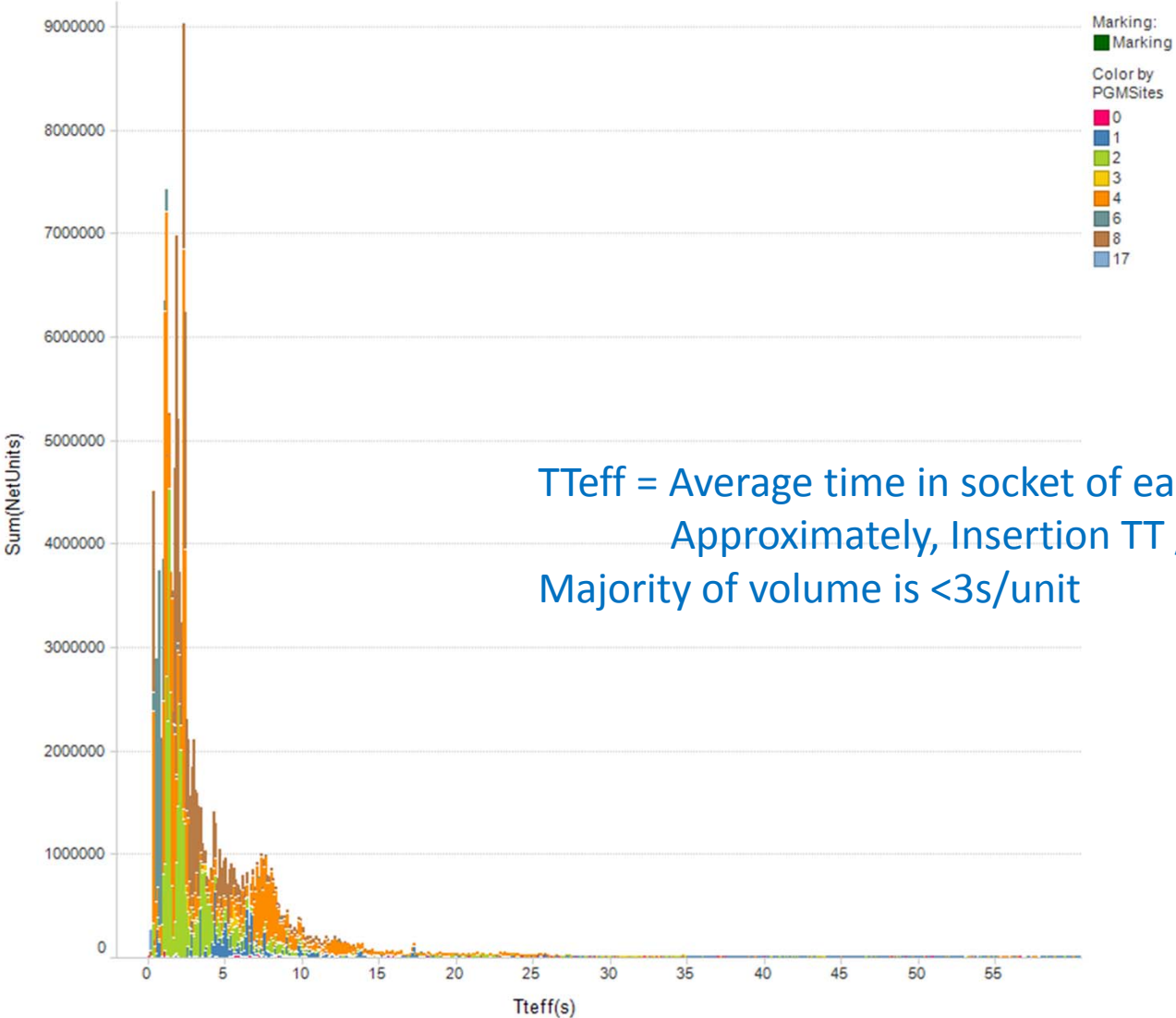
Filter Settings

- TestTimeInsert(s): (0.00 <= TestTimeInsert(s) <= 100.00) without empty values
- TestMode: (F)

Actual TI Factory Data – Digital/Embedded

MultiSite in the NonMemory World

Bar Chart



Tteff = Average time in socket of each unit
Approximately, Insertion TT / Site Count
Majority of volume is <3s/unit

Filter Settings

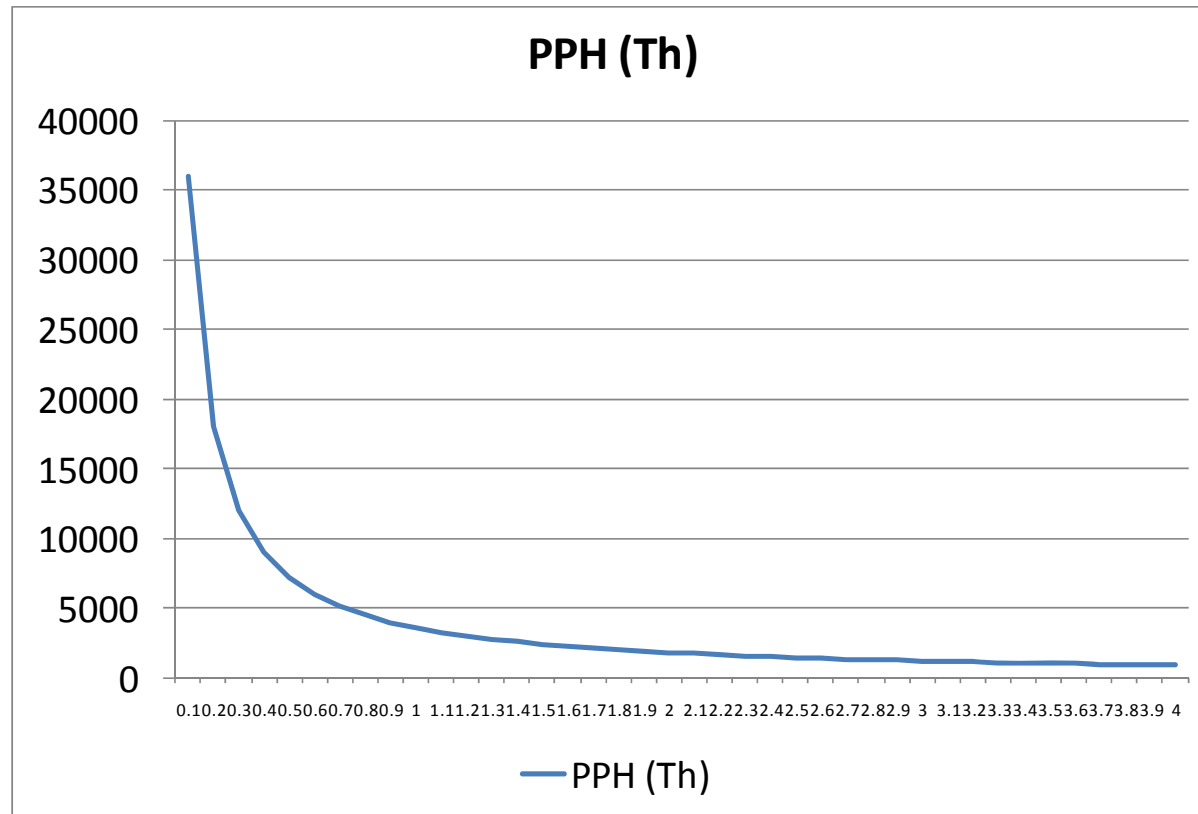
- TestTimeInsert(s): (0.00 <= TestTimeInsert(s) <= 100.00) without empty values
- TestMode: (F)

Actual TI Factory Data – Digital/Embedded

PARTS PER HOUR IN A REAL FACTORY

PPH vs Tteff

Simple-minded Models



PPH is not linear with Tteff

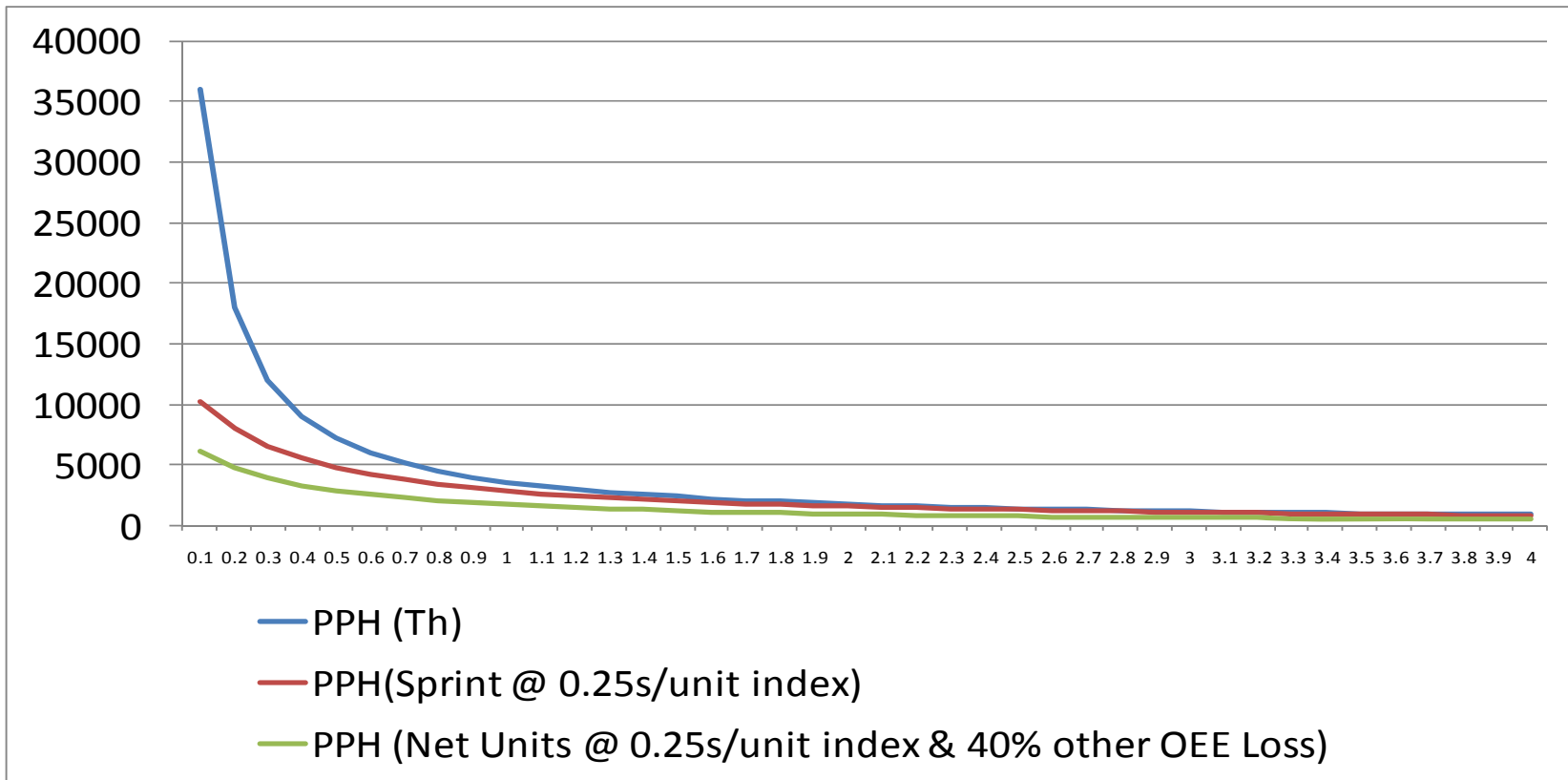
$1/t$ function ($3600/T_{\text{Teff}}$)

$1/t$ becomes unlimited as $t \rightarrow 0$

Hooray! Output approaches infinity as Tteff approaches 0!!!!

PPH vs Tteff

Simple-minded Models



PPH is not linear with Tteff

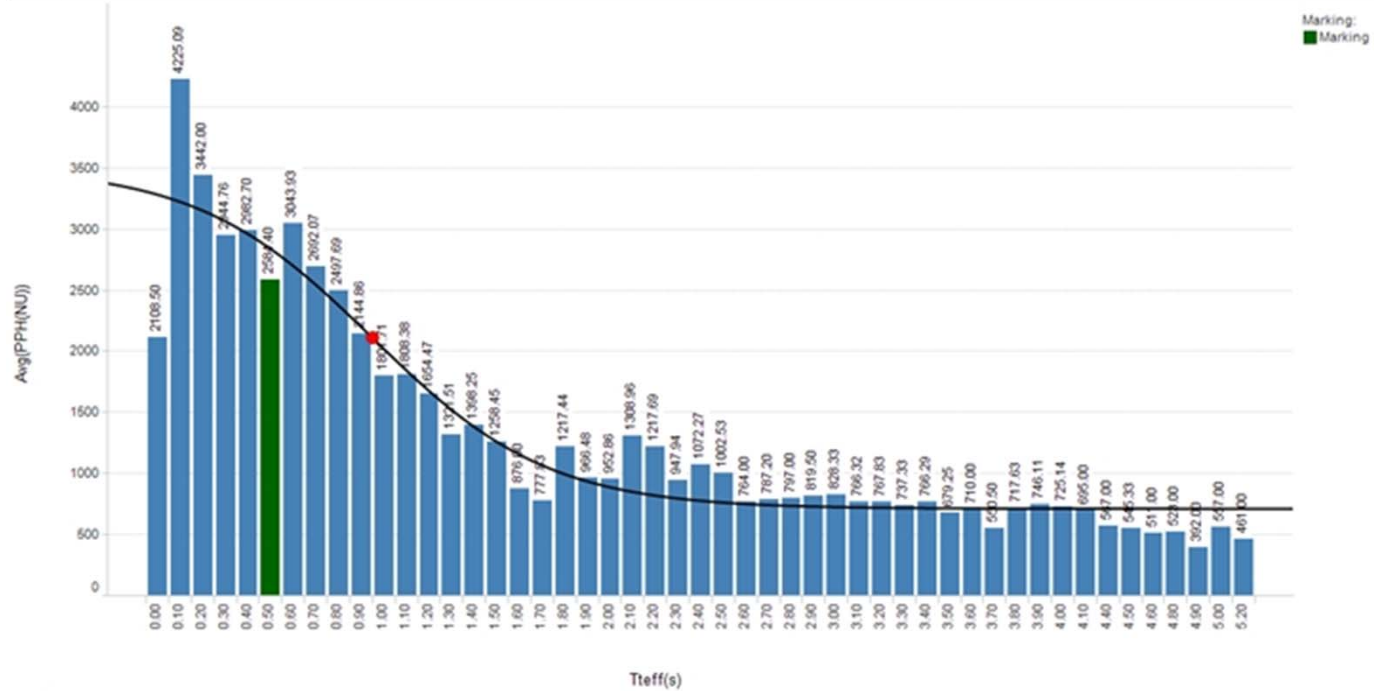
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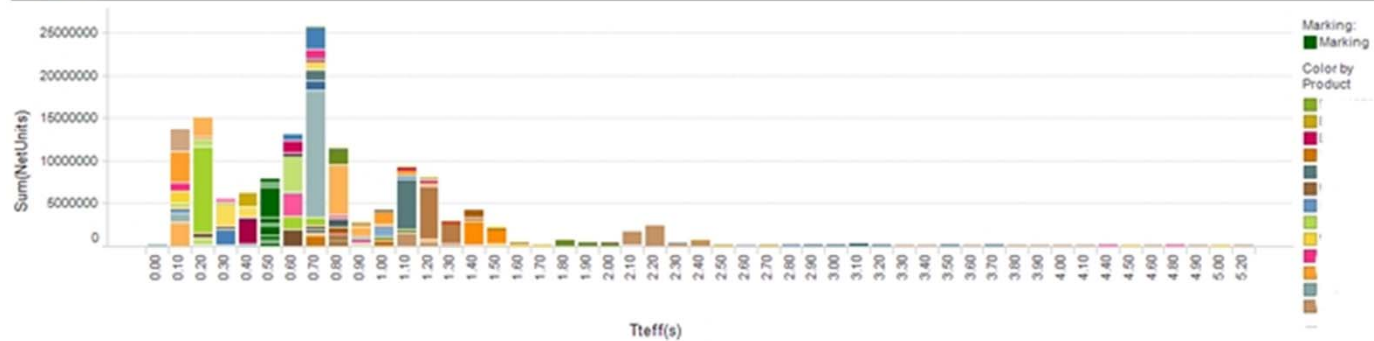
OEE loss, including Index Time loss, limits the curve

PPH vs TTeff TI Factory Data

Bar Chart



Bar Chart

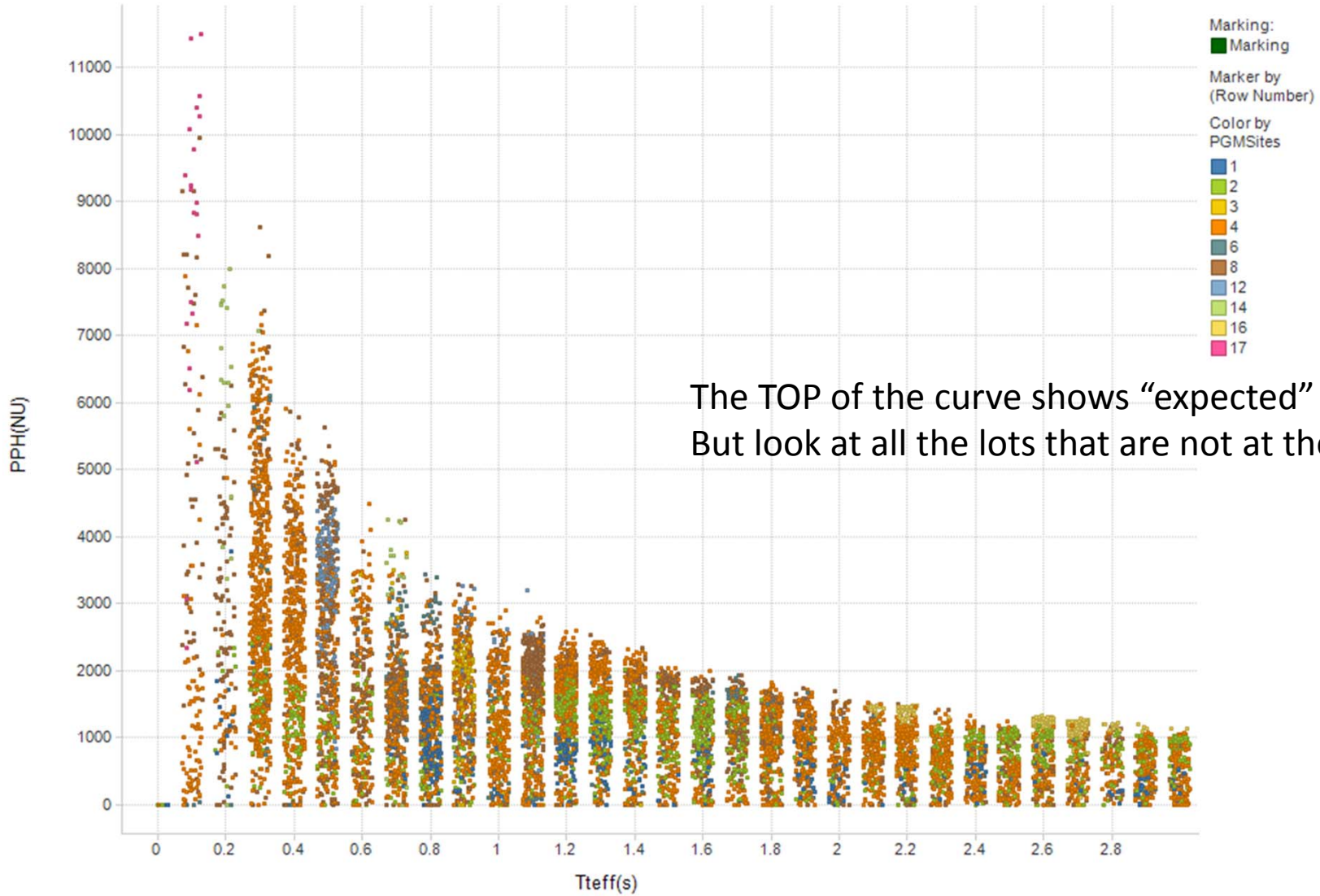


Filter Settings

- Units: (1000 <= Units <= 179729) without empty values
- Yield: (0.80 <= Yield <= 1.00) without empty values
- ScreenType: (FIRST_PASS, RESCREEN_AFTER_LOT_CLOSE, RESCREEN_SPC_FAIL, RETEST_REJECTS, UNKNOWN_SCREEN)
- TestArea: (FT, FT1, FT2, FTArea)
- TestMode: (F)

PPH vs Tteff - Analog

Scatter Plot

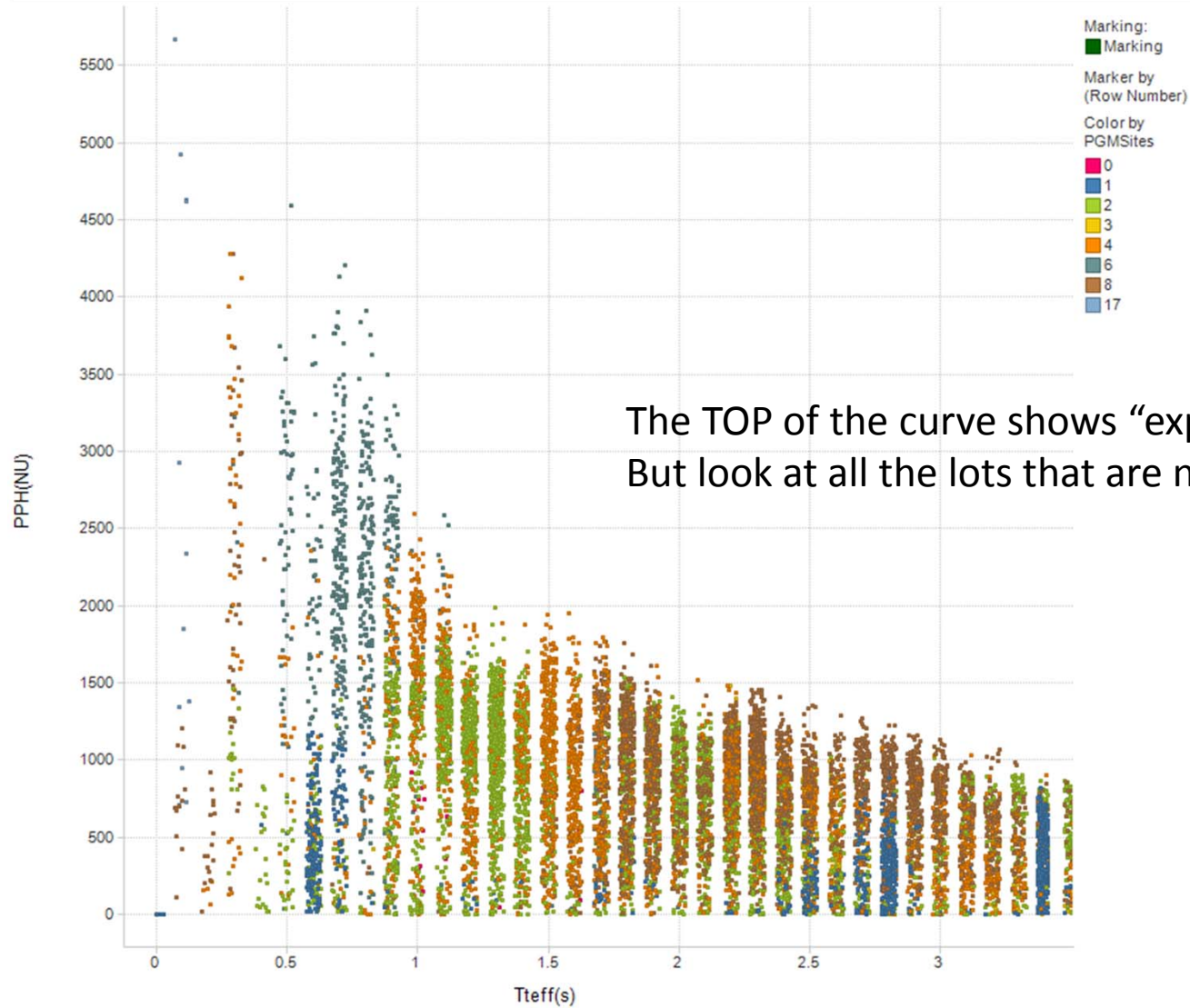


Filter Settings

- PGMSites: (1, 2, 3, 4, 6, 8, 12, 14, 16, 17)
- TestMode: (F)

PPH vs Tteff – Digital/Embedded

Scatter Plot



The TOP of the curve shows “expected”
But look at all the lots that are not at the top!

Filter Settings

- TestTimeInsert(s): (0.00 <= TestTimeInsert(s) <= 100.00) without empty values
- TestMode: (F)

CONCLUSIONS

A Couple Key Thoughts About Test

- In most cases, Test does not add value to the finished chip
 - This is especially true in NonMemory products
 - Therefore, any test cost is painful to chip makers
- Semiconductors are becoming more customized
 - There will be a very few high-volume applications
 - Big consumer products like iPhone
 - The vast majority of chips sold are low volume
 - At 0.5s T_{eff}, one tester can test 22Million NUB/Year!
 - “Low volume” is anything that consumes < ~ 2-3 testers
 - **50M NUB/Year is “low volume!”**

Conclusions

- Test Cost is going up as a % of total semiconductor manufacturing cost
 - This trend is worse in non-Memory semiconductors
- MultiSite has helped Memory alleviate this pain
 - Multisite improves TTeff
- TTeff improvement does not drive PPH improvement below approximately 1s/unit
- Almost everything is “low volume”
 - Lot changeover
 - Setup changeover
- What has to change?
 - Focus on multisite may be too strong, especially for analog and embedded
 - Material flow through test areas is key
 - Why do we need to test at all?

BACKUP

OEE Definition and Formula

OEE = Overall Equipment Efficiency

OEE is a recognized industry standard that is used to represent a measure of equipment efficiency. OEE represents the time to produce efficient or 'good' units in relationship to the total equipment time.

$$\text{OEE} = \frac{\text{Total Time Testing Good Units}}{\text{Total Operating Time}} \times 100$$