ELPIDA

FormFactor®
The MicroSpring® Company

DDR2 DRAM
High-Frequency Test at Probe (HFTAP)

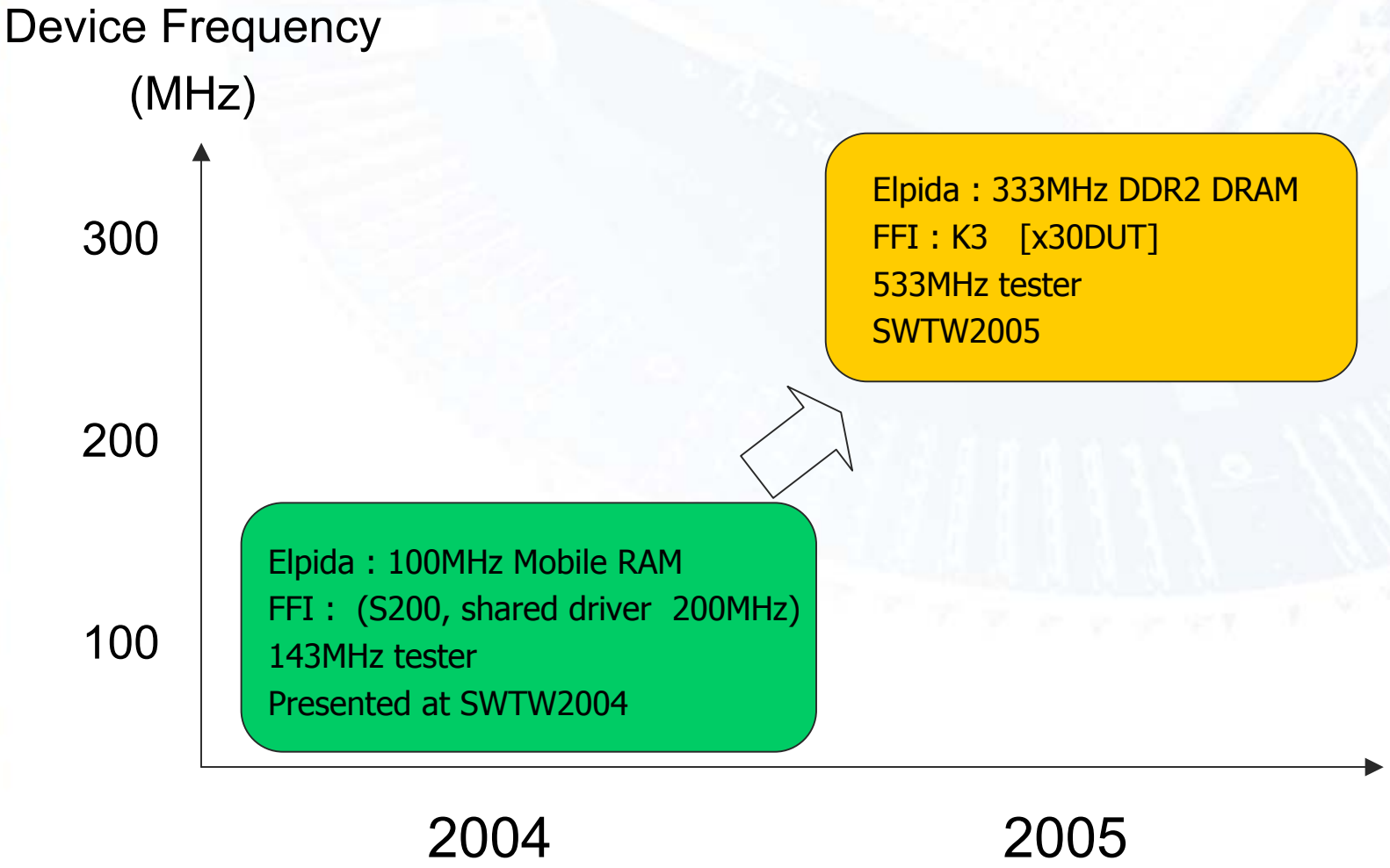
Masahide Ozawa Elpida Memory, Inc.
Yoichi Funatoko FormFactor Inc., Asia

Southwest Test Workshop 2005

Presentation Outline

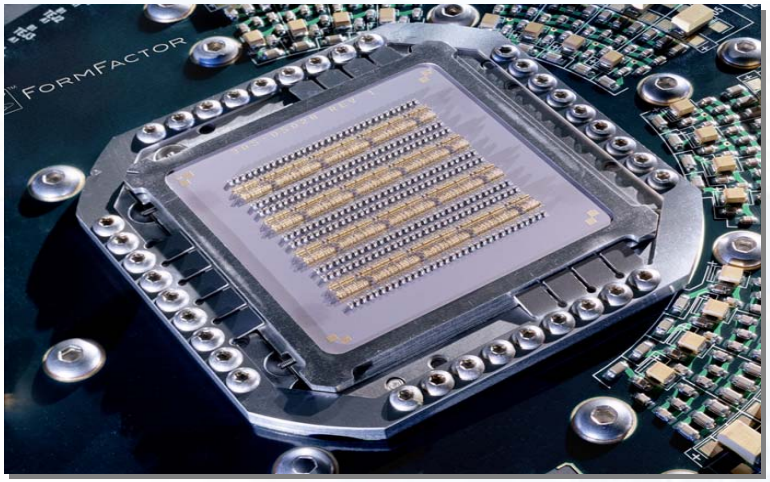
- Introduction
- DDR2 DRAM wafer-level-final-sort tests objectives and goals
- High performance probing technology solution
- New probing technology internal qualification
- Customer evaluation
- Summary and conclusion
- Follow on work

Wafer-Level Final-Sort Challenge



High Performance K3 Probing Solution

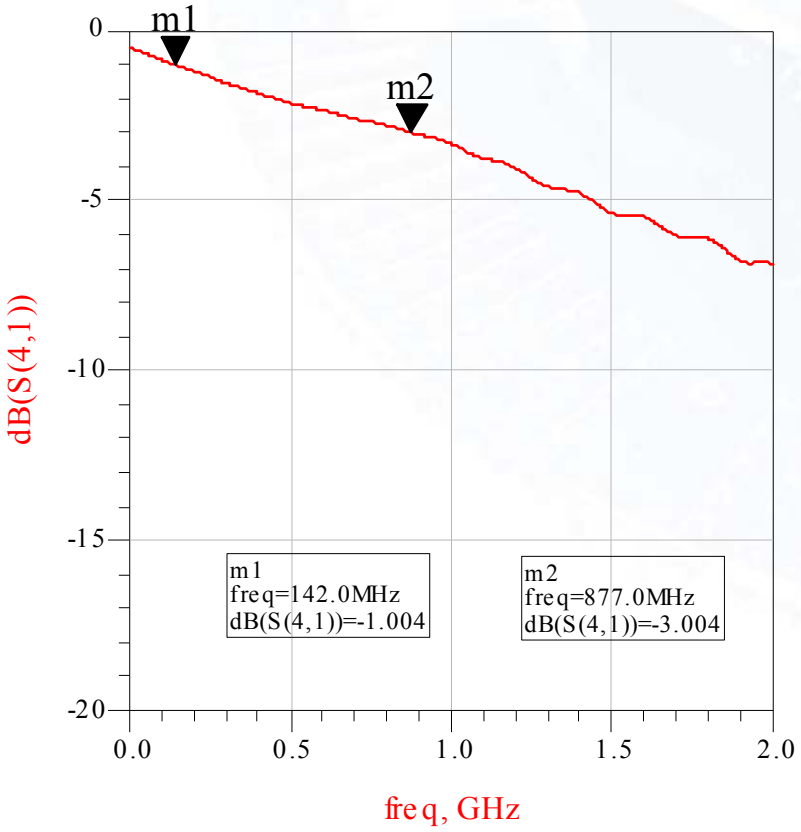
HFTAP™ probing technology



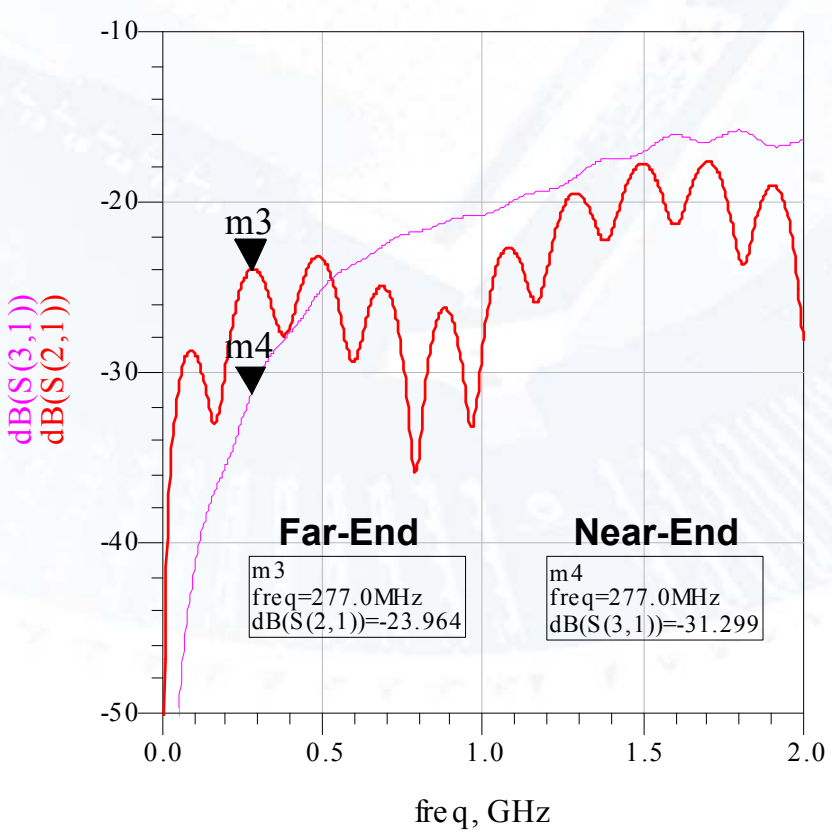
FFI K3 probing technology

K3 performance enables
DDR2 testing @ 333MHz / 667Mbs

FFI Attenuation & Cross-talk Simulation



Attenuation

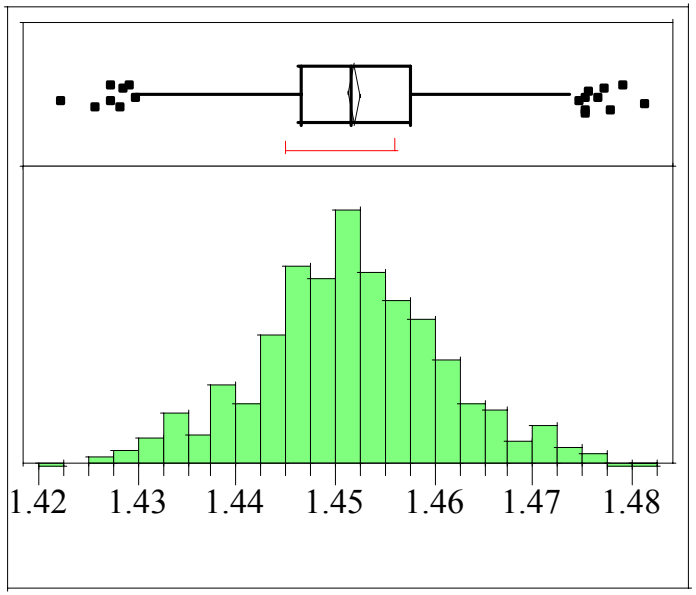


Cross-talk

FFI Internal qualification
Tpd Distribution by TDR Measurement

Distributions

FFI_(ns)



Quantiles

100.0%	maximum	1.4810
99.5%		1.4772
97.5%		1.4720
90.0%		1.4640
75.0%	quartile	1.4575
50.0%	median	1.4515
25.0%	quartile	1.4465
10.0%		1.4396
2.5%		1.4325
0.5%		1.4270
0.0%	minimum	1.4220

Moments

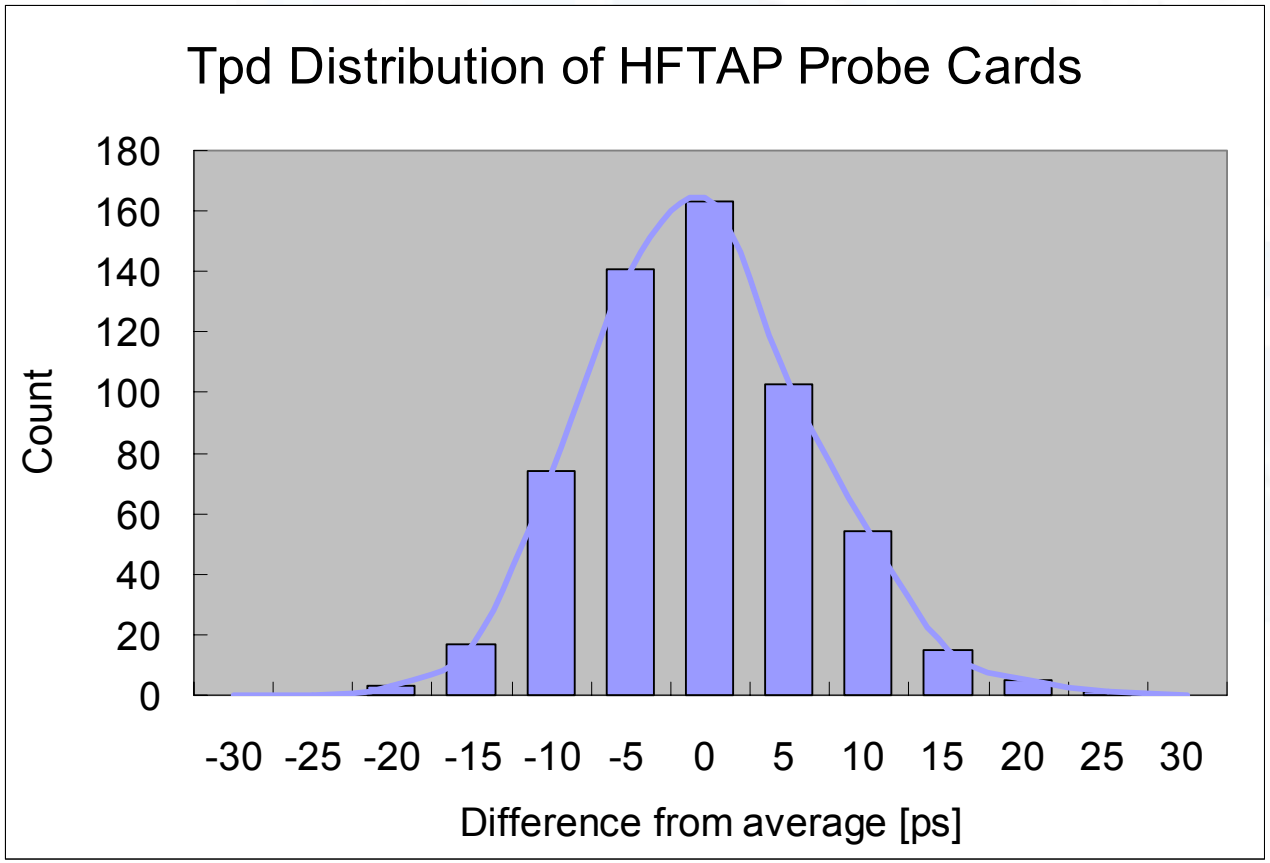
Mean	1.451825
Std Dev	0.0094868
Std Err Mean	0.0003536
upper 95% Mean	1.4525191
lower 95% Mean	1.4511309
N	720

Channel to channel skew was +/- 30ps

Elpida Evaluation Items

- Basic characteristic
  - Skew
  - Waveform
  - Tr/Tf
  - Jitter
- Device evaluation
  - At-speed test
  - Correlation between wafer and package
    - TCK-VDD Shmoo
    - AC parameters
    - Idd current

Elpida evaluation: Channel to Channel Skew (TDR Measurement)



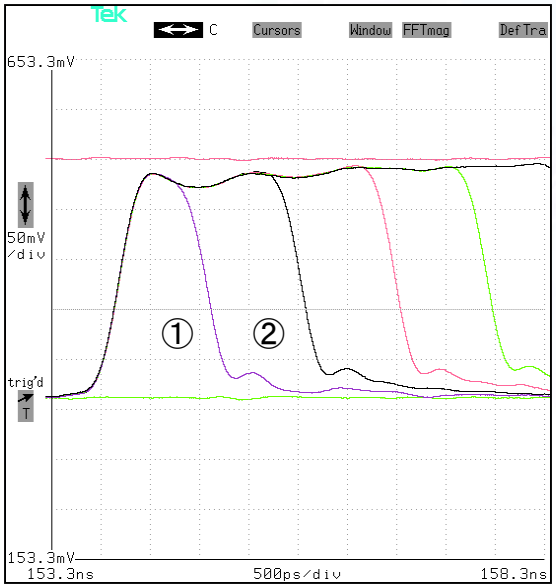
Tpd spec (±75ps) is satisfied.

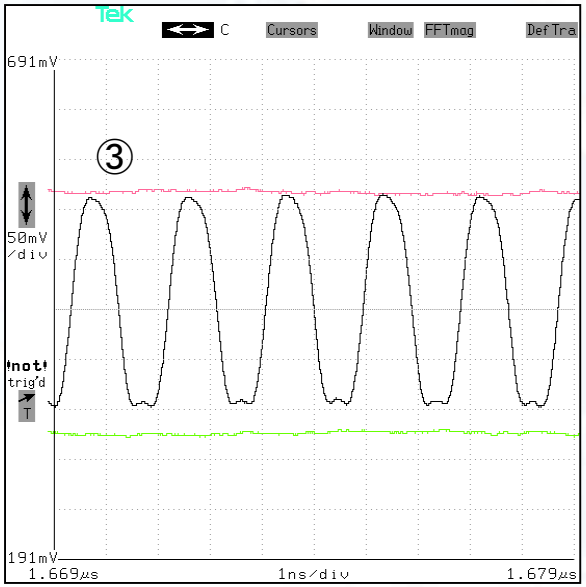
n=576

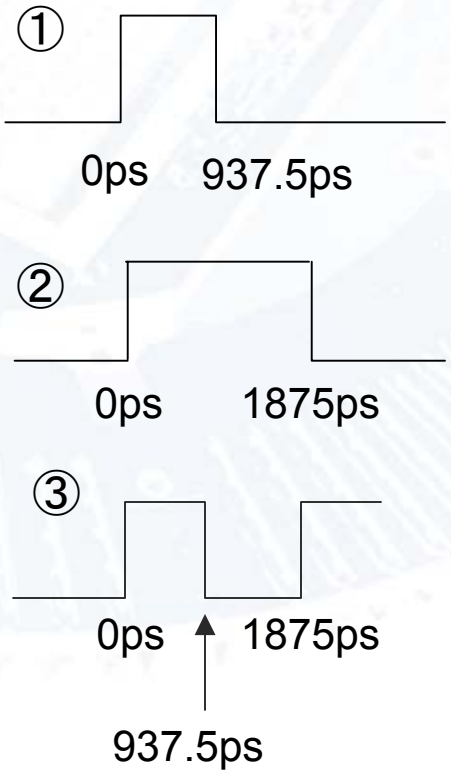
σ [ps]	3σ [ps]
7.7	23.2

σ : Standard Deviation

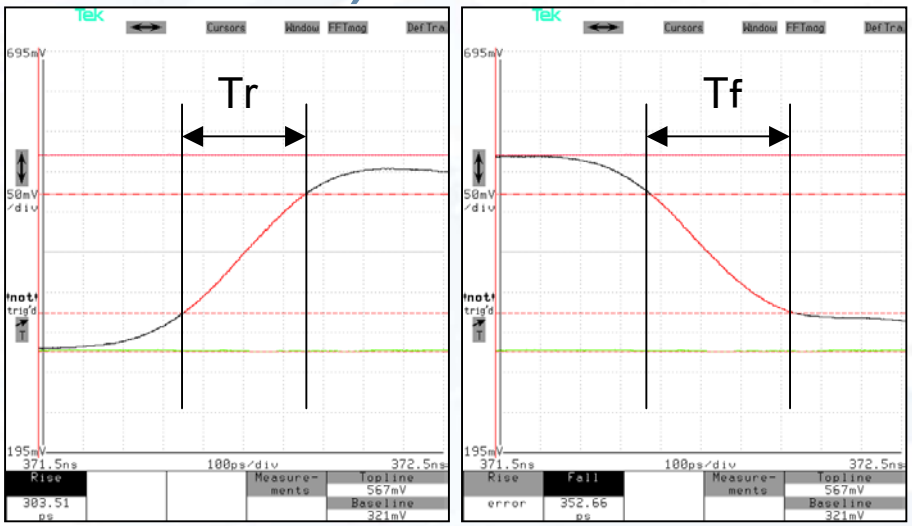
Elpida evaluation: Input Waveform (Amplitude 0.5V Vt:0.9V)

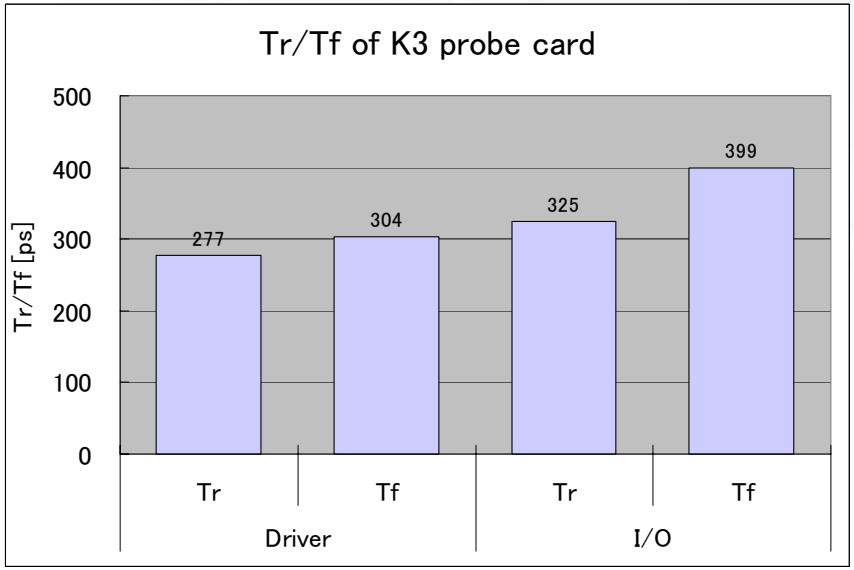




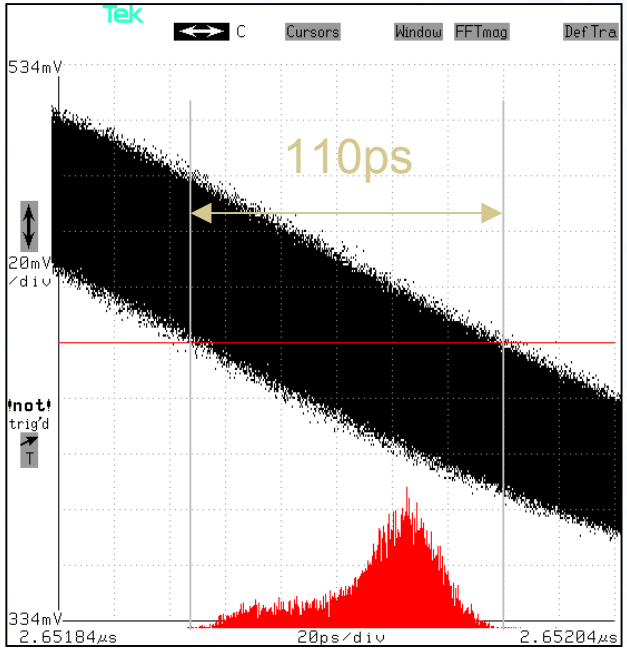


Elpida evaluation: Tr/Tf (Amplitude 0.5V 20-80%, Vt:0.9V)

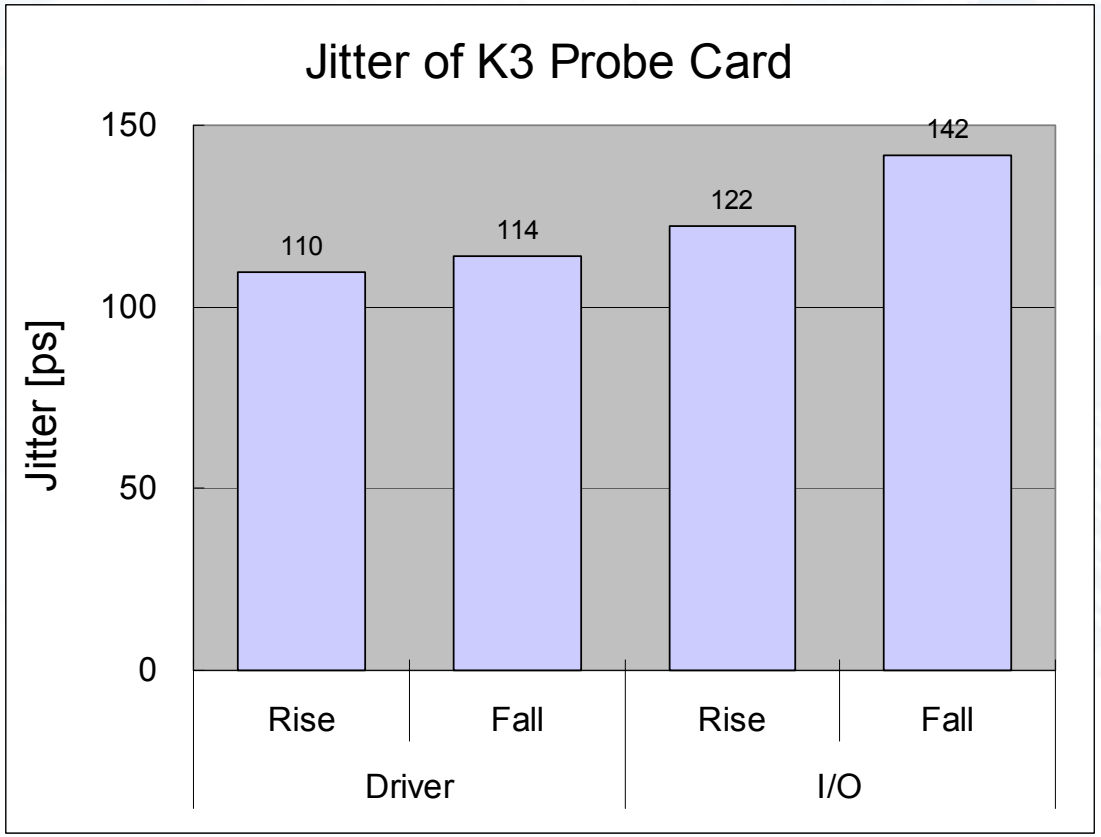




Elpida evaluation: Jitter



※Evaluated at 533MHz



The source of jitter is caused by attenuation, cross talk, and tester timing control.

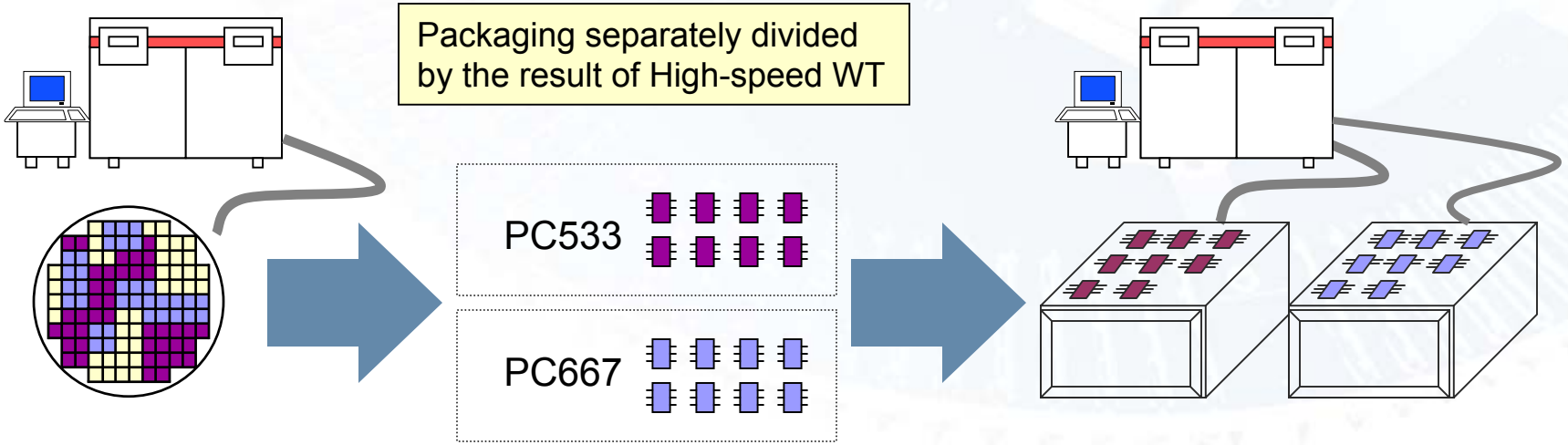
Jitter of K3 is similar of existing final tester

Elpida evaluation: At-Speed Test (1)

High-speed WT

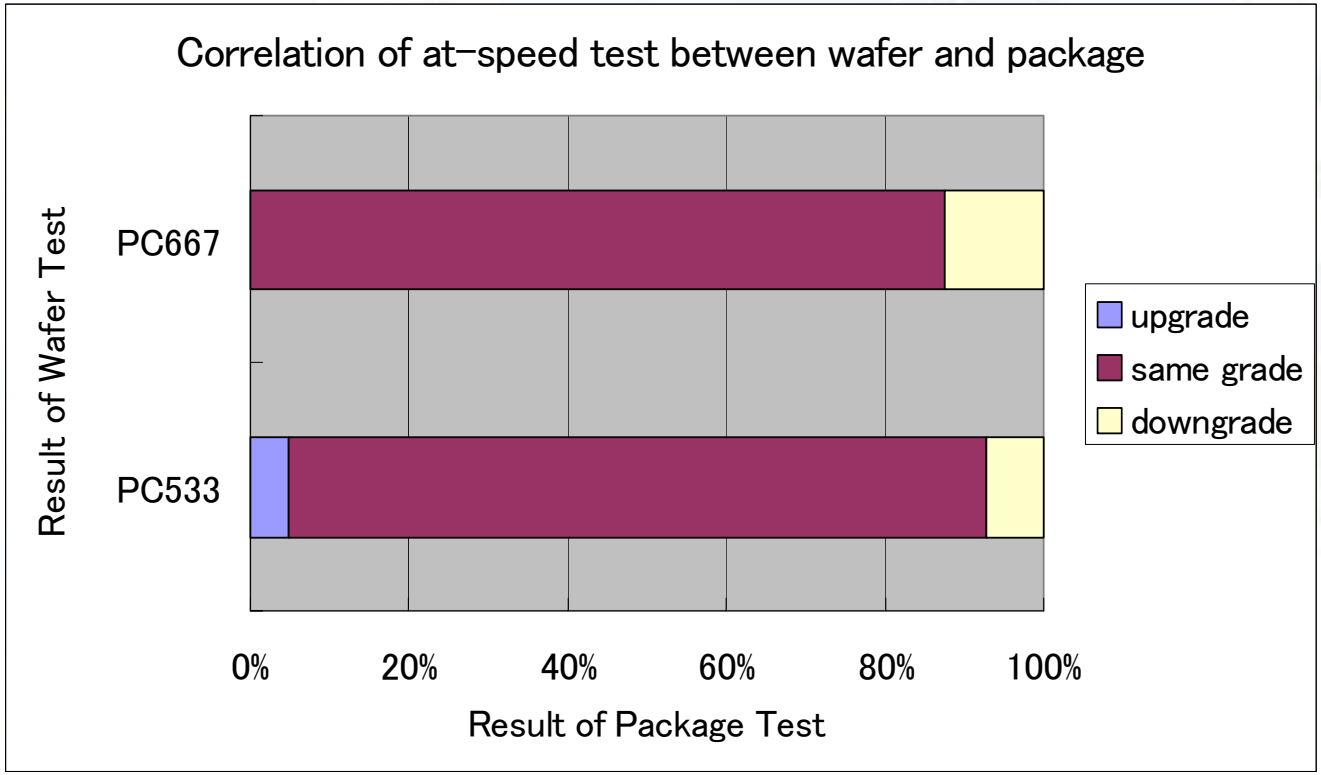
Assembly

Package Test



Elpida evaluation: At-Speed Test (2)

- Correlation Result

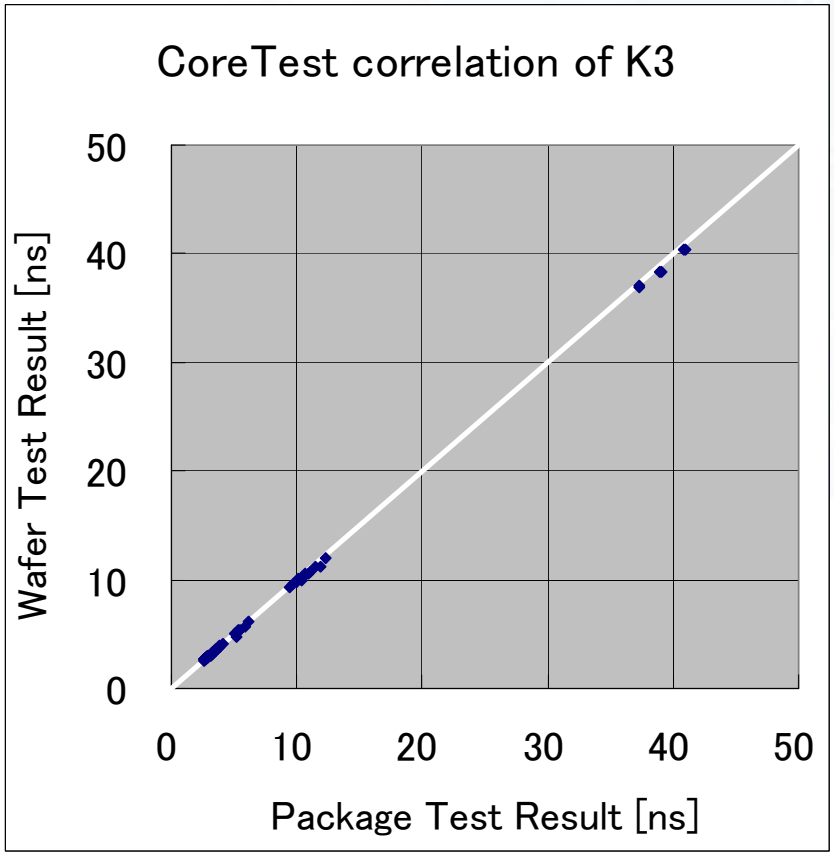


	Correlation Ratio
K3	87.0%

Correlation test result was similar to final test.

Elpida evaluation: Correlation (core test)

Test Item: TCK-VDD Shmoo for some pattern



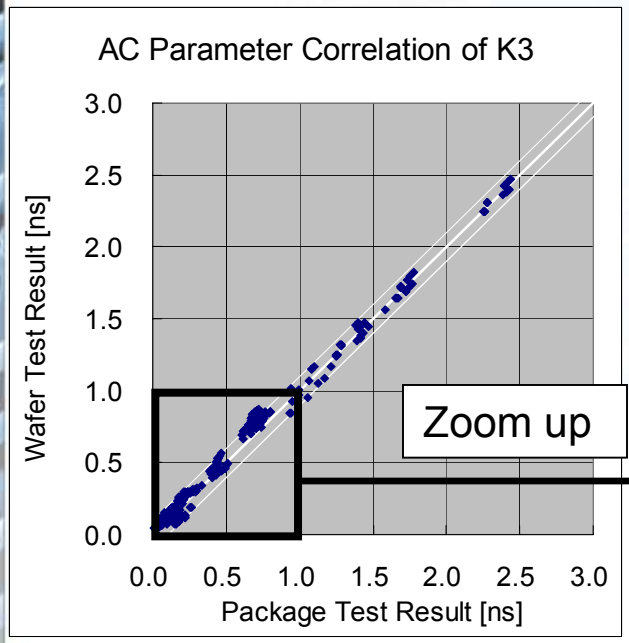
These are evaluated at high temperature with Vdd set in 3points.

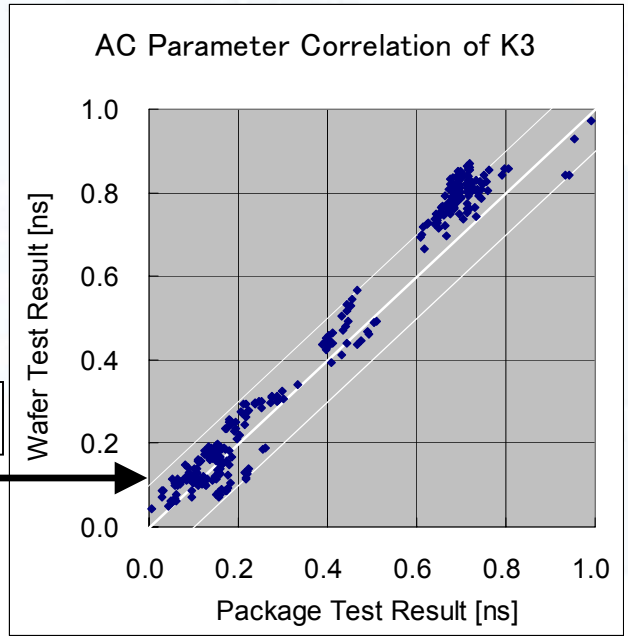
White line means “Be equal” for wafer test and package test. If plot is near this white line, correlation is OK.

Correlated well

Elpida evaluation: Correlation (AC parameters) 1

Test Item: AC Parameters (setup, hold, TCK etc.)





※Sub line is indicated the range of Timing accuracy (±100ps)

These are evaluated at high temperature with Vdd set in 3points.

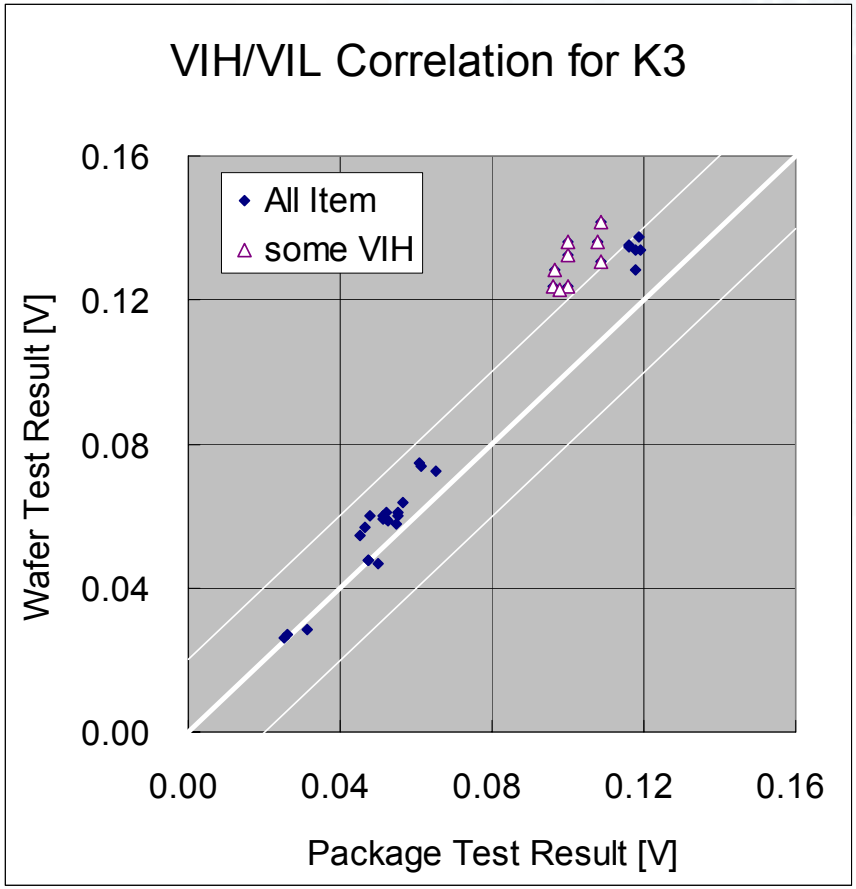
Compared by package test result

•Different 100ps～150ps for some test item

Available for testing with adjustment

Elpida evaluation: Correlation (AC parameters) 2

Test Item: AC Parameters (VIH/VIL)



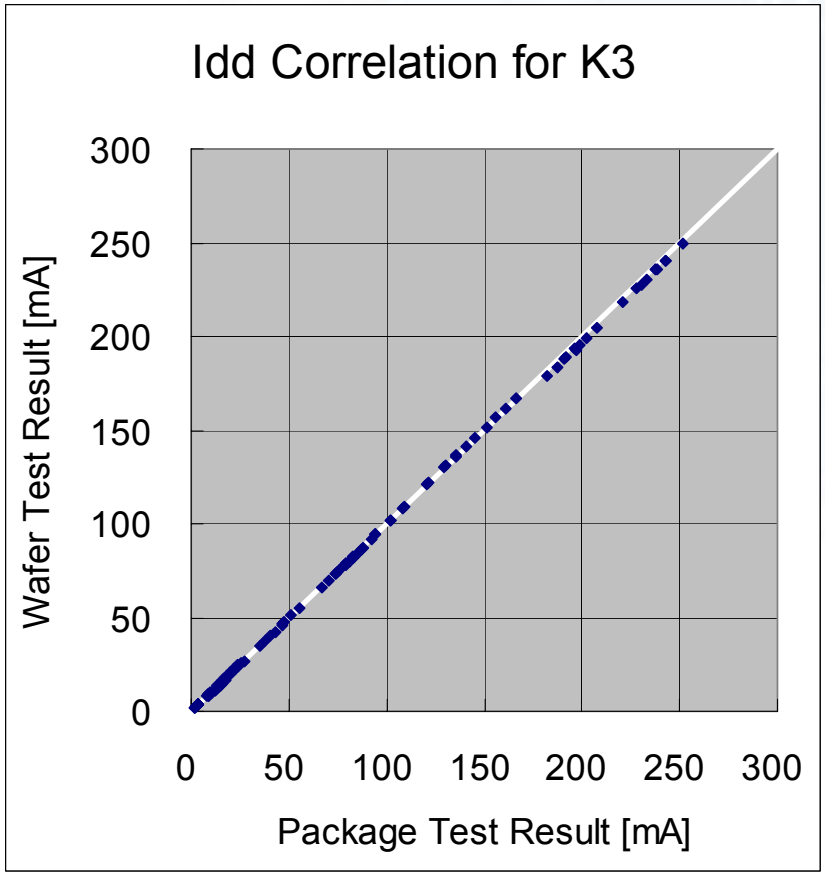
These are evaluated at high temperature with Vdd set in 3points.

・40mV higher VIH for specific pins

Available for testing with adjustment

Elpida evaluation: Correlation (Idd)

Test Item: Idd Current



These are evaluated at high temperature with Vdd set in 3points.

Correlated well

Summary and Conclusion

Objectives	Results
Basic characteristics (Waveform, Tr/Tf, Jitter)	PC667 (333MHz) evaluation passed all criteria.
Correlation between wafer and package test	Correlation test result was similar to final test.
High-frequency wafer testing	Available to device measurement for 333MHz DDR2 DRAM at device speed testing

Follow-on Work

- Elpida Memory, Inc.
  - Further evaluation for volume production
- FormFactor, Inc.
  - Higher parallelism K3 [x64 DUT & x 128 DUT]
  - Production qualification at > 300 MHz.
  - Customer evaluation for 500MHz and beyond with K5