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Cost Effective 1,000V High Voltage Parametric Test Technique

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Overview

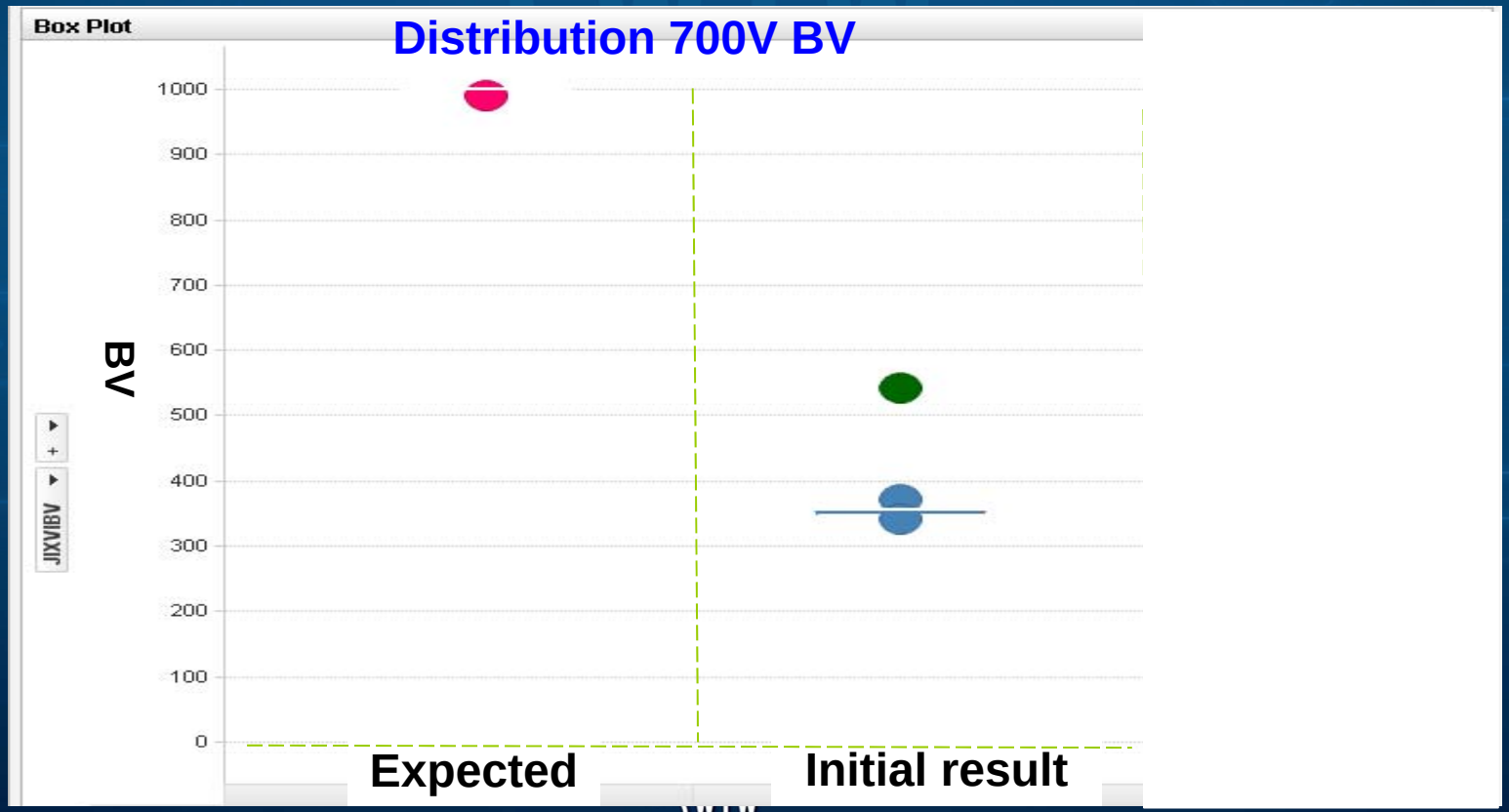
- DC Parametric Test Objectives
- Problem Statement
- New Test Technique
- Probe Card Development
- Measurement Result
- Summary and Conclusion
- Follow-on Work

DC Parametric Test Objectives

- **Stable Measurement of Breakdown Voltage at 1,000V**
- **Stable Low Leak Test (Input Level)**
- **Low Cost Test System for Production**

Problem Statement

- **Conventional Test System**
  - Unstable Voltage Measurement Result
  - Voltage Degradation



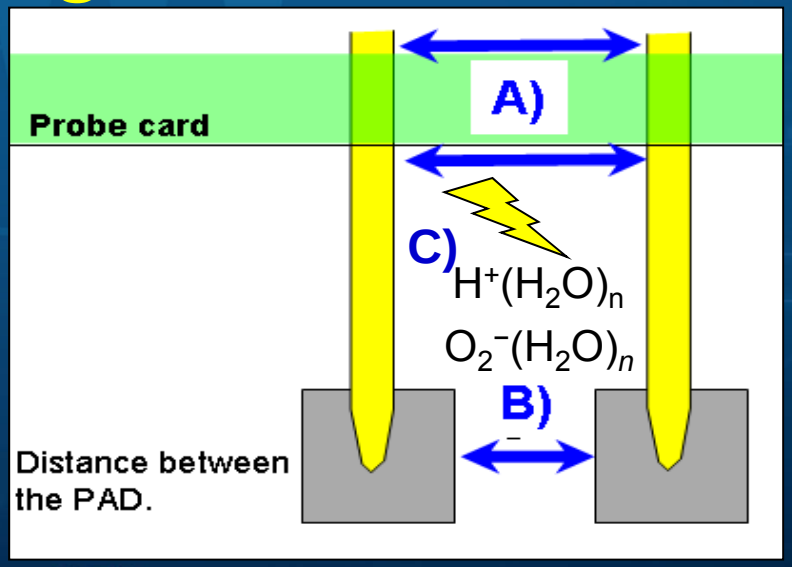
Investigate Voltage Degradation Root Cause

A) Leak by discharge on surface of the Probe Card.

B) Leak by discharge on surface of the device.

C) Atmospheric Humidity

Current Leak through cluster ion formation



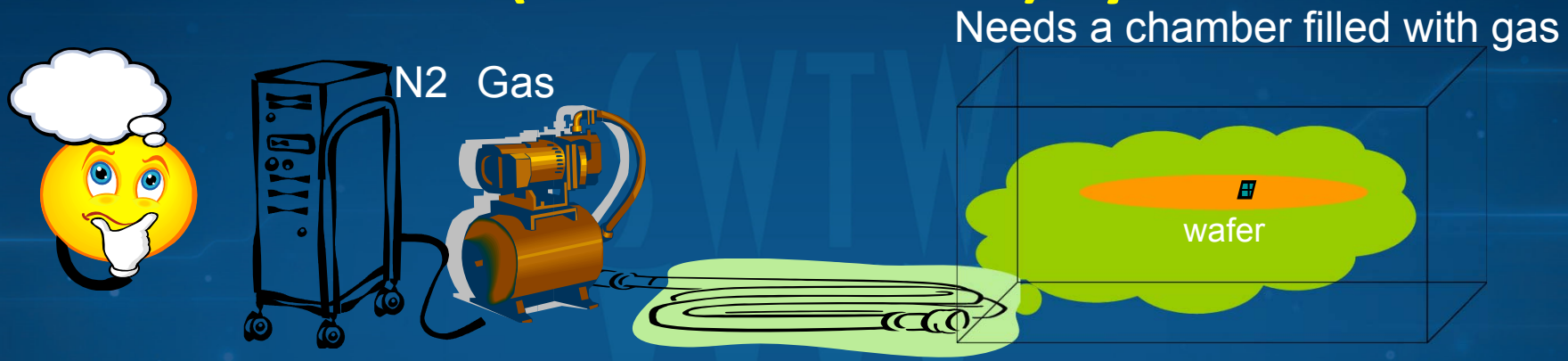
Conventional High Voltage Test System

- **Hardware**
  - Chamber type prober
  - N2 Gas System
- **Cost**
  - Expensive
- **Operation**
  - Wait 20minutes for filling gas

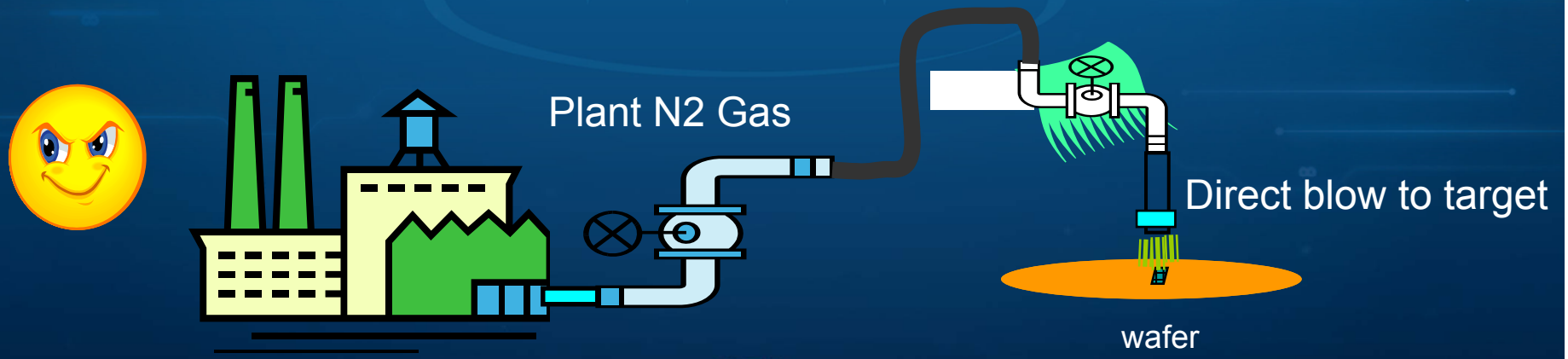
Too Expensive and Low Productivity

New Test System Idea

- **Conventional (Chamber Based) System**



- **Texas Instruments Miho Idea (Pinpoint)**

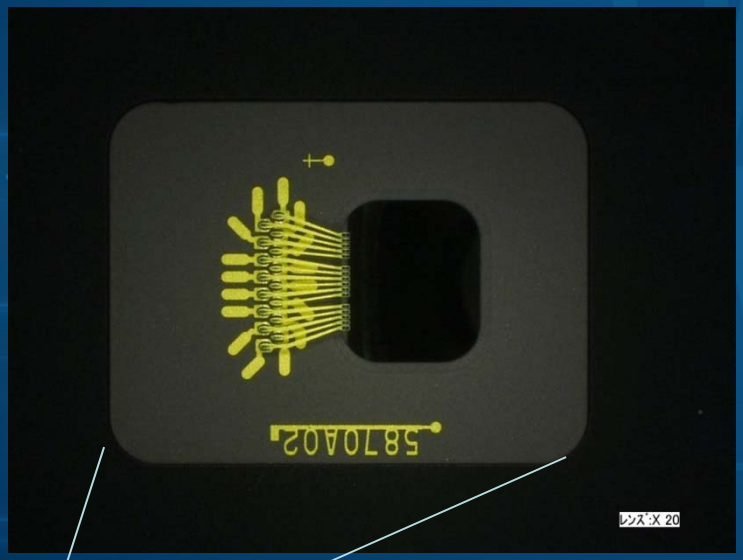


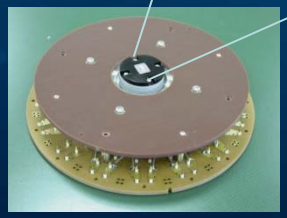
New Test System

	Chamber Type Prober Conventional System	Dry Gas Purge Probe Card New System
Hardware	• Low Temp Chamber Type Prober • N2 Gas System	• Nozzle for N2 Gas • Probe Card Development for Production Use
Cost	500 (relative to new system)	1
Operation	Wait 20minutes for filling gas	No wait time

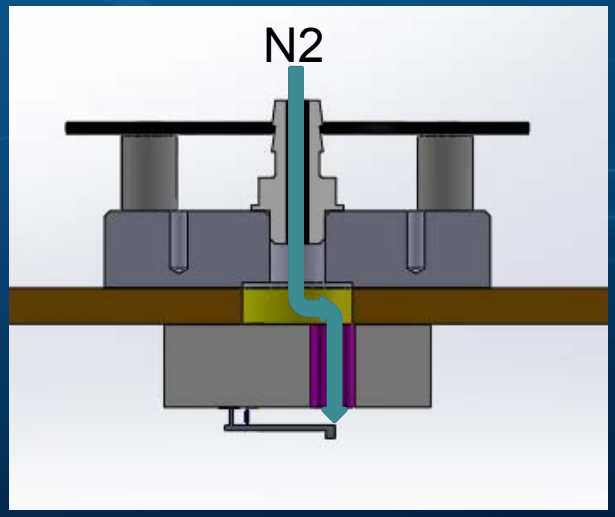
Probe Card Development

- N2 Gas Hole on Ceramic





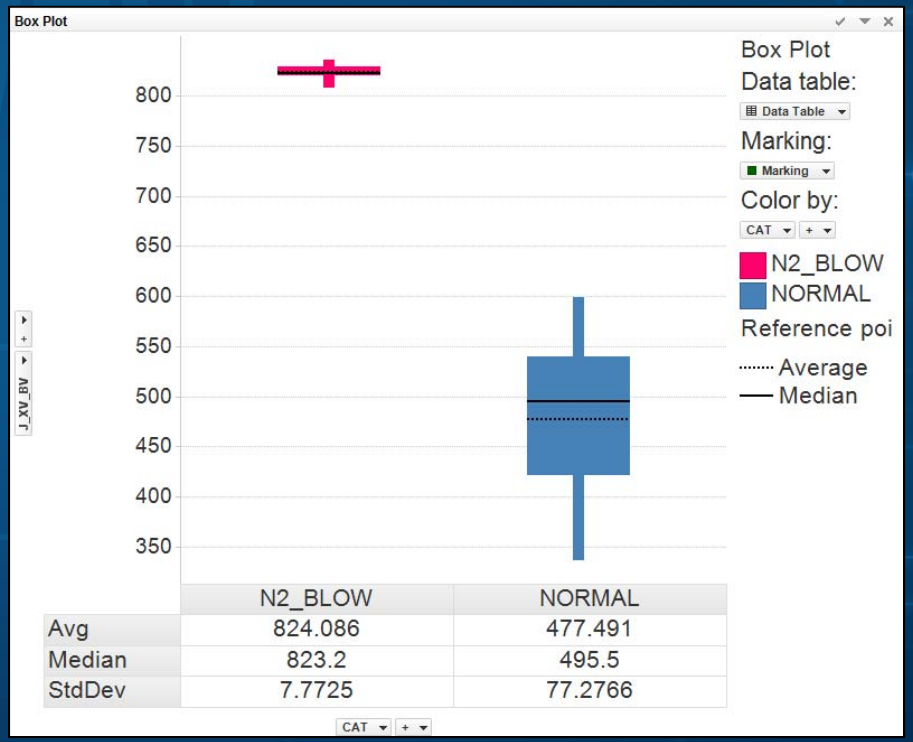
- N2 Gas Mechanical Option



High Voltage Test Data

- **Achieved a stable High Voltage measurement by pinpoint blow system.**
- **No Operation wait time required.**

High voltage test
N2 Blow vs. Normal(No N2 Blow)

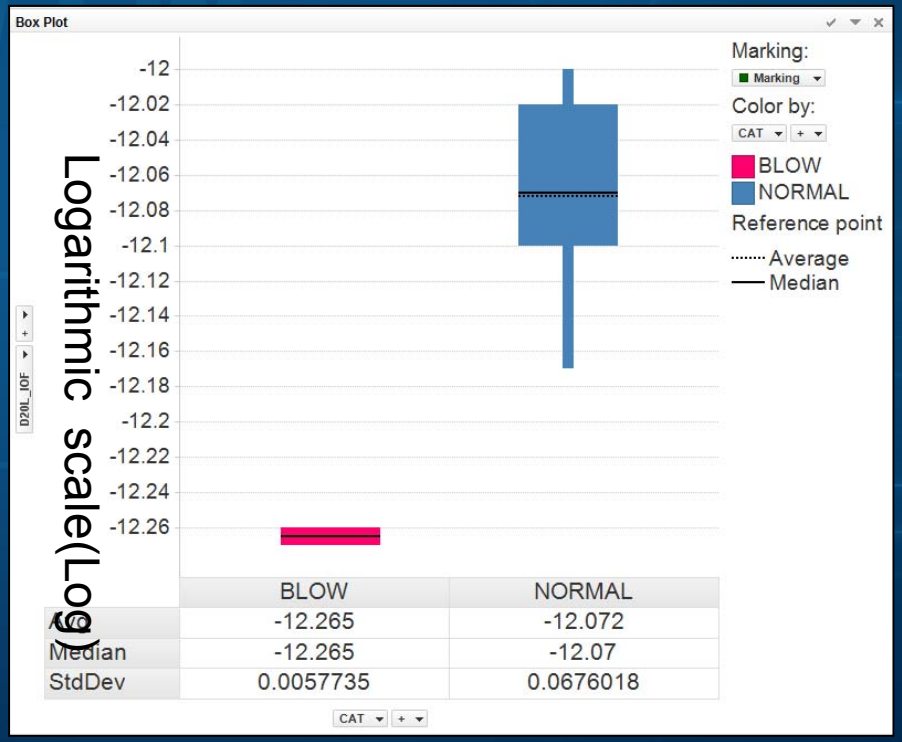


	N2_BLOW	NORMAL
Avg	824.086	477.491
Median	823.2	495.5
StdDev	7.7725	77.2766

Leak Test Data

- **Stable Leak Test Result with N2 blow**

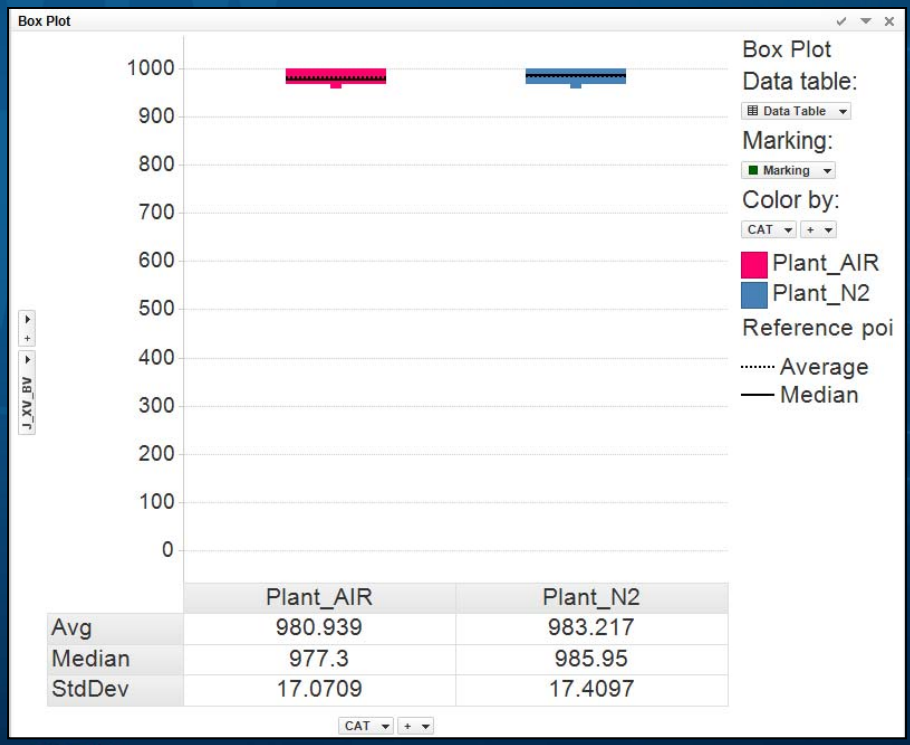
Leak test
*CMOS Low voltage element
N2 Blow vs. Normal(No N2 Blow)



Condensed Dry Air Blow vs. N2 Blow

- **Same distribution for both CDA and N2 Blow.**

High voltage test
CDA Blow vs. N2 Blow

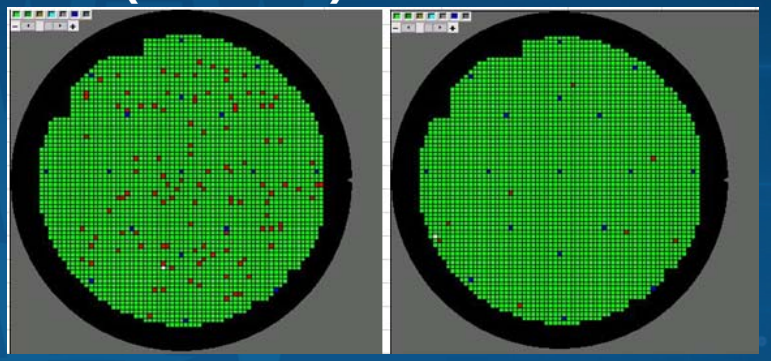


Additional Benefit : Cleaning

- **Wafer Particle Number Data by N2 Blow**

STD	N2 BLOW
112	10

STD(No Blow) N2 Blow

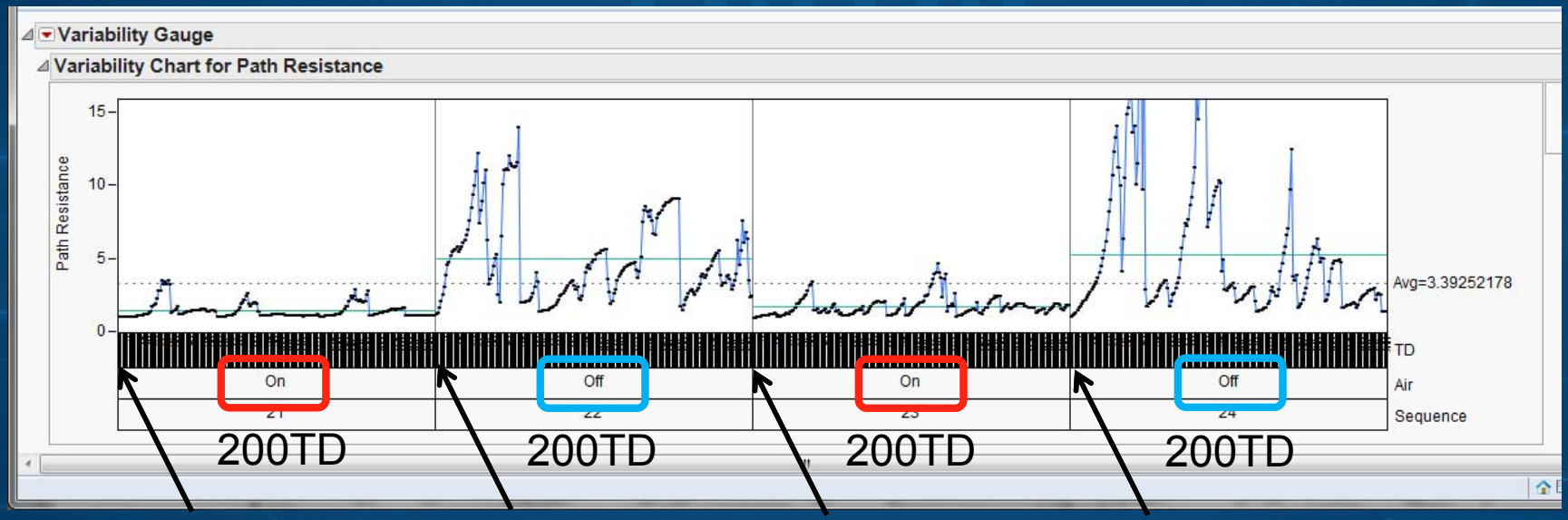


- **Probe Tip Cleaning by CDA Blow**
  - Loose Al Debris on Tip was removed by CDA Blow

Probe Tip Cleaning by CDA Blow Video

Additional Benefit : Stable Cres by CDA On

- **FFI T3 Spring Al Wafer 2Pin Path Resistance Evaluation by CDA On/Off**



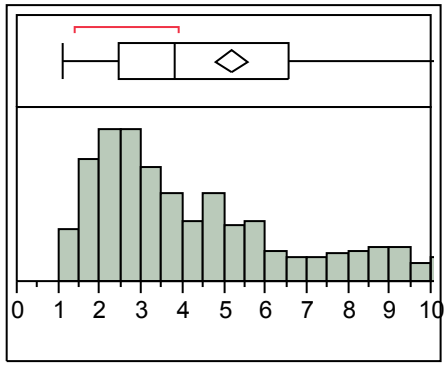
- **Verified CDA was effective on FormFactor MicroSpring Cres**

Reference : SWTW2006 Austin, Grayson, and Wegleitner, CRES Control Using CDA as a Shielding Gas

Additional Benefit : Stable Cres by CDA On

Distributions Ai =Off

Path Resistance

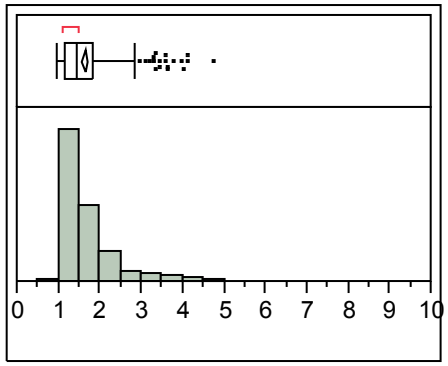


Quantiles		
100.0%	maximum	31.7277
99.5%		20.4029
97.5%		16.3228
90.0%		10.2139
75.0%	quartile	6.58943
50.0%	median	3.7978
25.0%	quartile	2.47238
10.0%		1.8111
2.5%		1.42032
0.5%		1.16589
0.0%	minimum	1.10807

Summary Statistics	
Mean	5.1650153
Std Dev	3.948681
Std Err Mean	0.1974341
Upper 95% Mean	5.5531563
Lower 95% Mean	4.7768743
N	400

Distributions Ai =On

Path Resistance

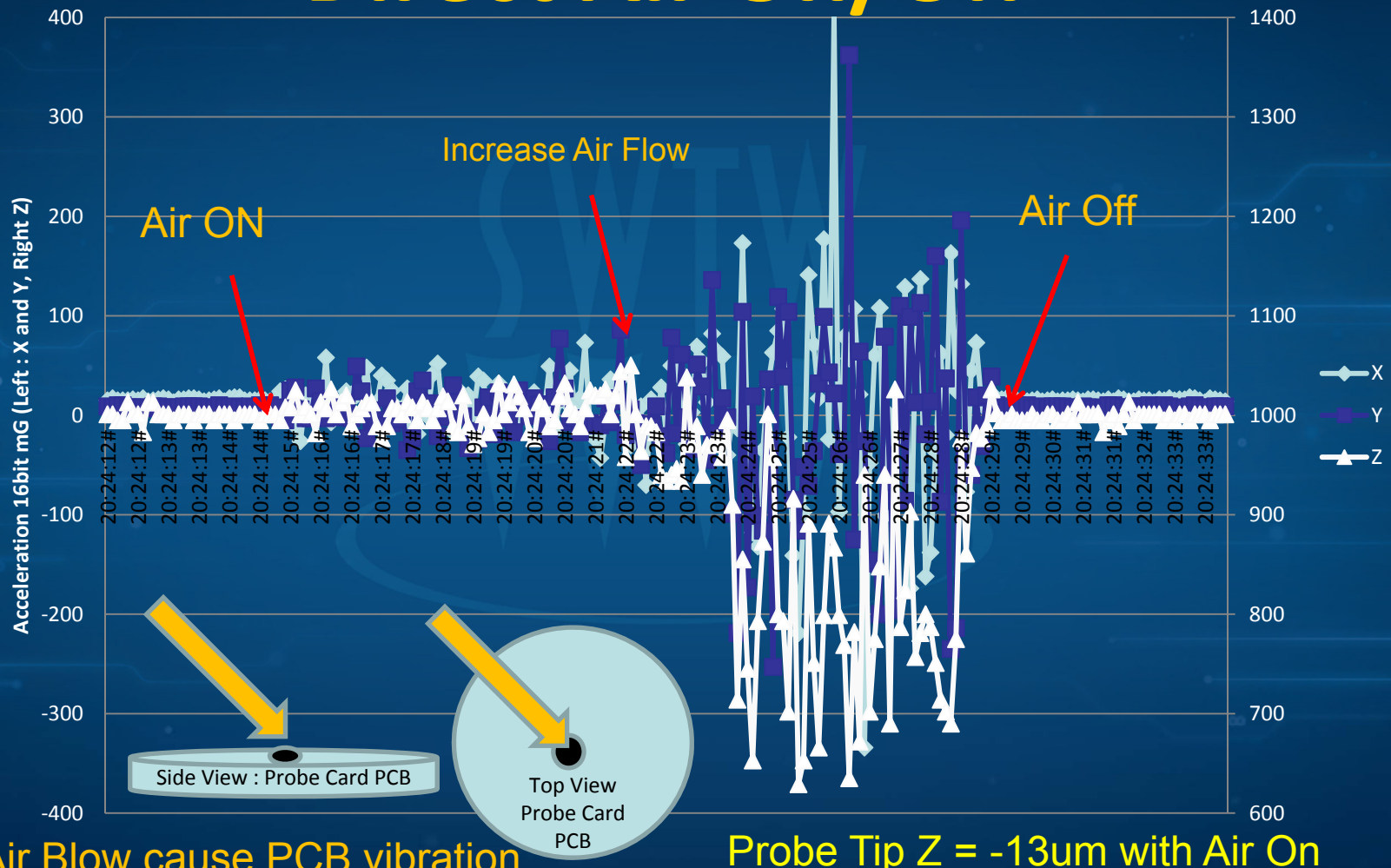


Quantiles		
100.0%	maximum	4.71496
99.5%		4.11593
97.5%		3.5676
90.0%		2.37372
75.0%	quartile	1.85915
50.0%	median	1.45491
25.0%	quartile	1.17833
10.0%		1.12432
2.5%		1.06719
0.5%		1.00764
0.0%	minimum	0.97336

Summary Statistics	
Mean	1.6200283
Std Dev	0.6098033
Std Err Mean	0.0304902
Upper 95% Mean	1.6799697
Lower 95% Mean	1.5600868
N	400

2Pin Path Resistance

Probe Card PCB Vibration with PCB Direct Air On/Off



Direct Air Blow cause PCB vibration

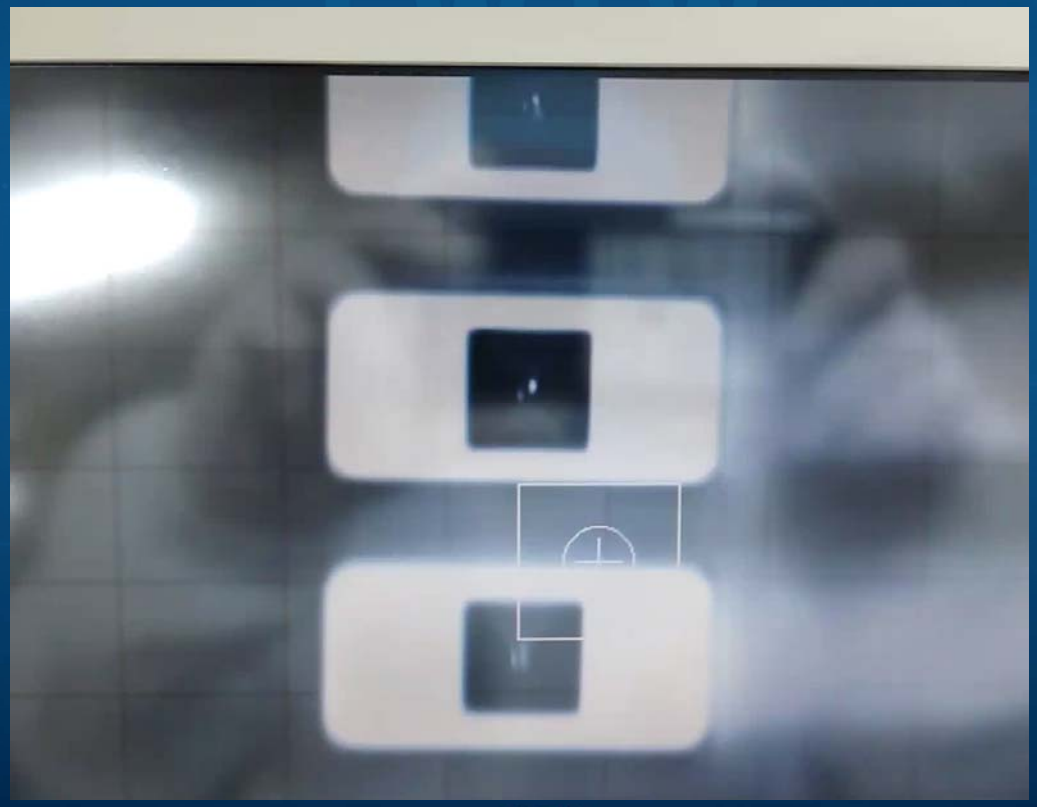
Probe Tip Z = -13um with Air On

Require Electrical Auto Z Arcing Countermeasure

Probe Tip Vibration Video by N2 Flow Rate

N2 Mechanical Option Probe Card Evaluation

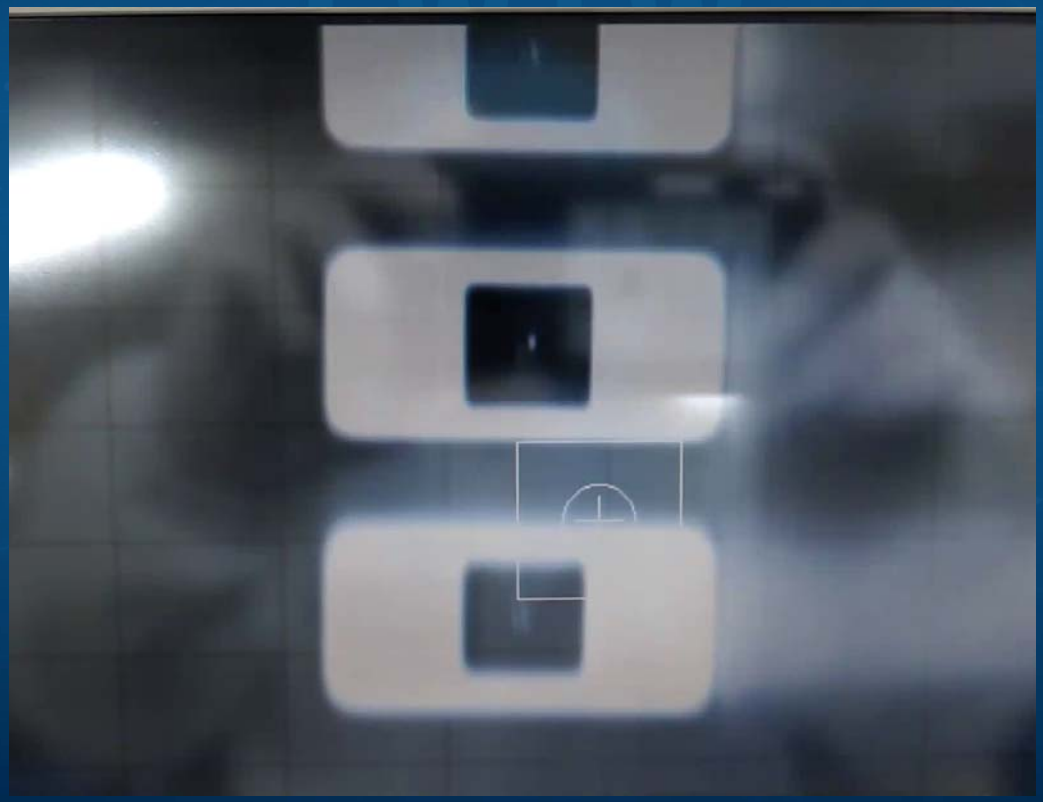
- 70L/min



Probe Tip Vibration Video by N2 Flow Rate

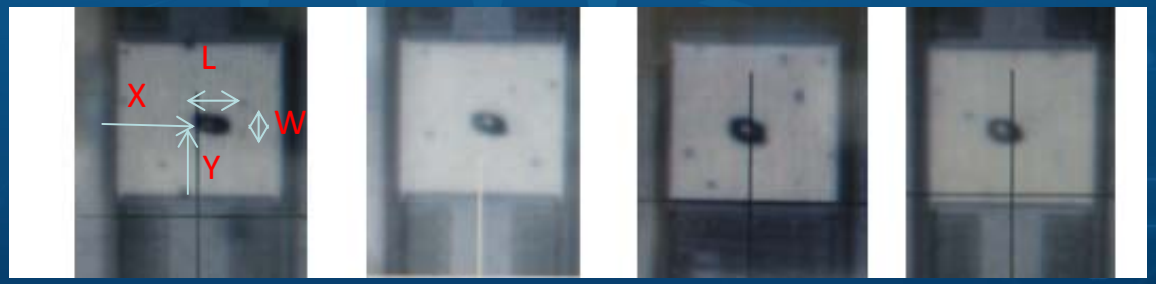
N2 Mechanical Option Probe Card Evaluation

- 130L/min



Prober Alignment and Scrub Mark Position Evaluation by N2 Flow Rate

Flow(L/min)	0	50	70	80
Auto Setup	Pass	Pass	Pass/Error	Error
Manual Setup	Pass	Pass	Pass	Pass
Scrub Mark Position	Pass	Pass	Pass	Pass
X Margin(um)	33.1	32.7	26.3	25.2
Y Margin(um)	30.9	30.4	28.3	30.2
Scrub Length (um)	14	12	13	12
Scrub Width (um)	6	6	6	6



- Vibration Affected Prober Tip Alignment
- No Major Change for Scrub Mark Position
- Need to optimize Flow rate and direction

Summary : New Test System

	Chamber Type Prober Conventional System	Dry Gas Purge Probe Card New System
Hardware	• Low Temp Chamber Type Prober • N2 Gas System	• Nozzle for N2 Gas/CDA • **Evaluated N2 Gas/CDA Mechanical Option Probe Card**
Cost	500 (relative to new system)	1
Operation	Wait 20minutes for filling gas	No wait time

Summary :Test Result

	No CDA/N2 Blow	CDA/N2 Blow
High Voltage Test	<600V Standard Deviation 77.27	>800V Standard Deviation 7.77 9.9X Improvement
Leak Test	Standard Deviation 0.067	Standard Deviation 0.005 13.4X Improvement
Cleaning Wafer	Number of Particle 112/wafer	Number of Particle 10/wafer 11.2X Improvement
Cleaning Probe Tip	Al debris stick on probe tip	Remove loose Al Debris on Tip
Contact Resistance	Standard Deviation 3.94	Standard Deviation 0.60 6.5X Improvement

Conclusion

- Successfully Developed Cost Effective High Voltage 1,000V Measurement System.
- Probe Card was evaluated for N2 Gas and CDA(Compressed Dry Air) system.
- New Measurement System was released for production.
- The other benefit, Stable Leakage and Contact Resistance, and Cleaning effect observed.

Follow On Work

- **>1,000V High Voltage Test**
- **Probe Card Ceramic Hole Opening Process**
  - Improve Lead-time
  - Improve Yield

Acknowledgements

- **Team Member**
  - Texas Instruments, Japan
    - Kenji Sasame
    - Koichi Sato
    - Kiwamu Yuasa
  - FormFactor
    - Larry Levy
    - Hiromitsu Sasanami
    - Shinpei Yoshida

- **References**
  - SWTW2006 : Austin, Grayson, and Wegleitner, CRES Control Using CDA as a Shielding Gas