# MicroForce™ Probing for Devices with Low-k ILD Materials

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Southwest Test Conference, Long Beach, CA
June, 2003

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# Industry Requirements for Probing Advanced Flip Chip Bumped Devices

- Lower Force Probing
  - Low-k ILD materials are more fragile
  - Low probe force desired to minimize damage to flip chip bump and ILD materials
- Low and Consistent Contact Resistance
  - High frequency and high power applications require tighter Cres control
  - Applications require higher current to pass through probe system without much resistance
- Finer Pitch
  - Roadmap to 100μm pitch requires revolutionary probing approach



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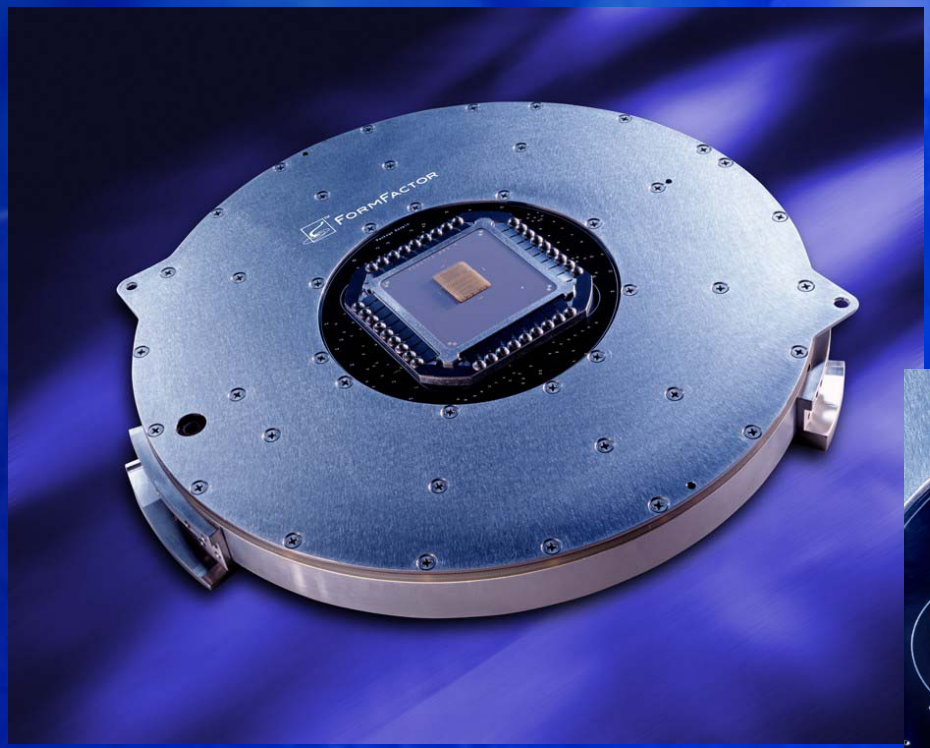
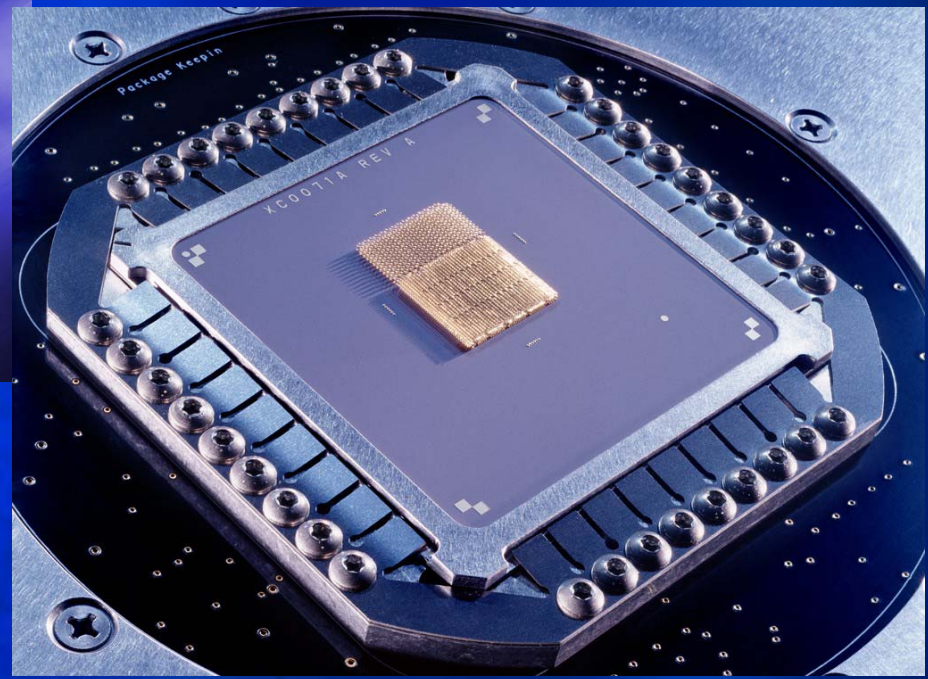
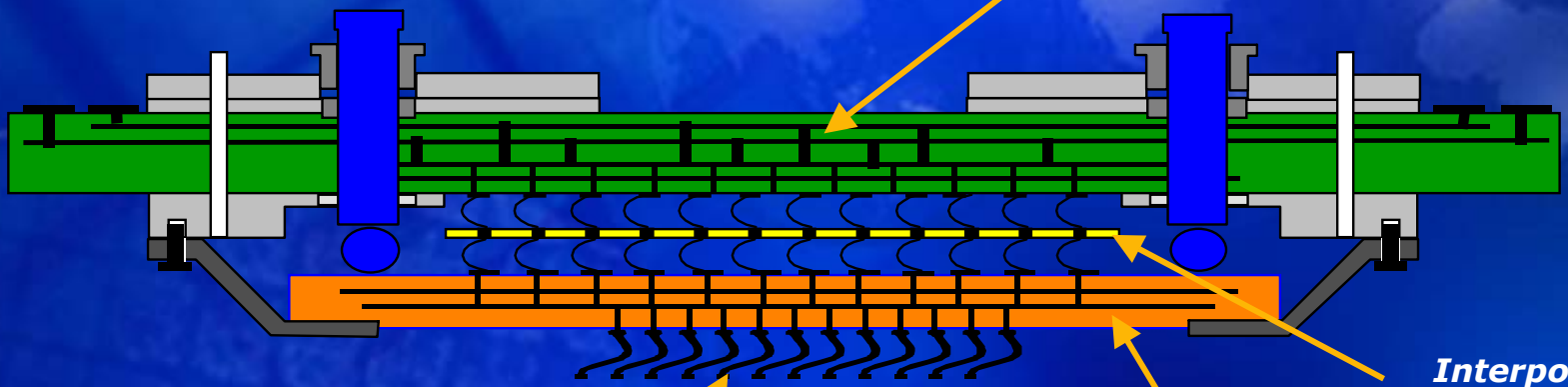
# FormFactor BladeRunner™ Probe Cards (For Probing Bumped Wafers)



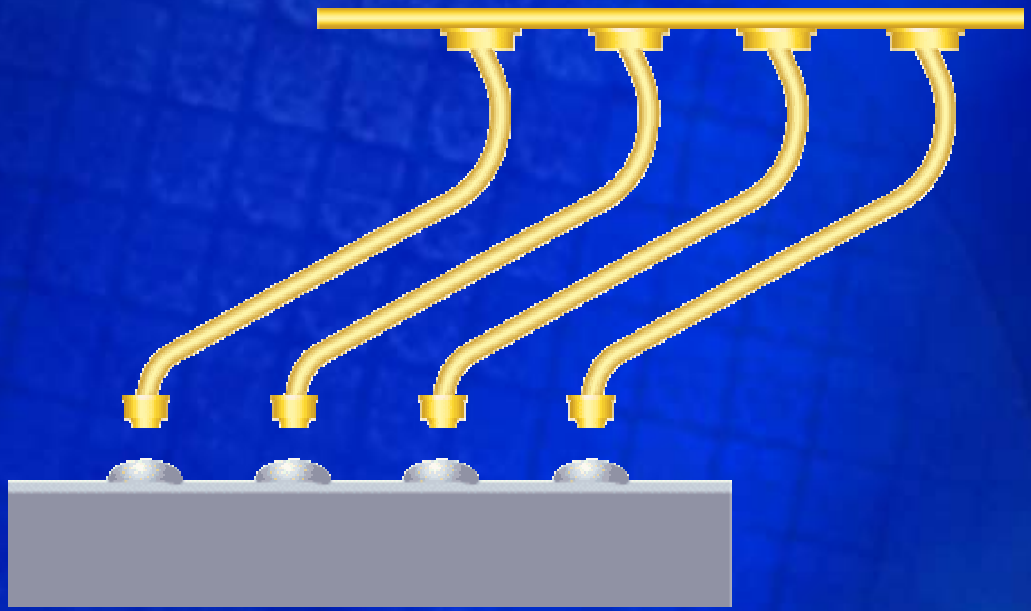
# FormFactor Probe Card Architecture

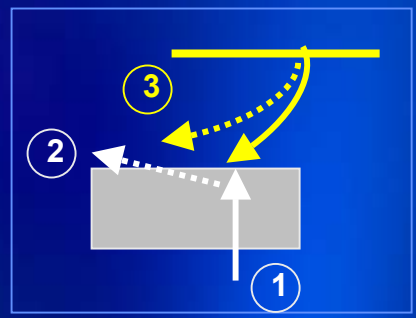



MicroSpring™ Contact for
Probing Flip Chip Bumps

# MicroForce™ Probing Definition

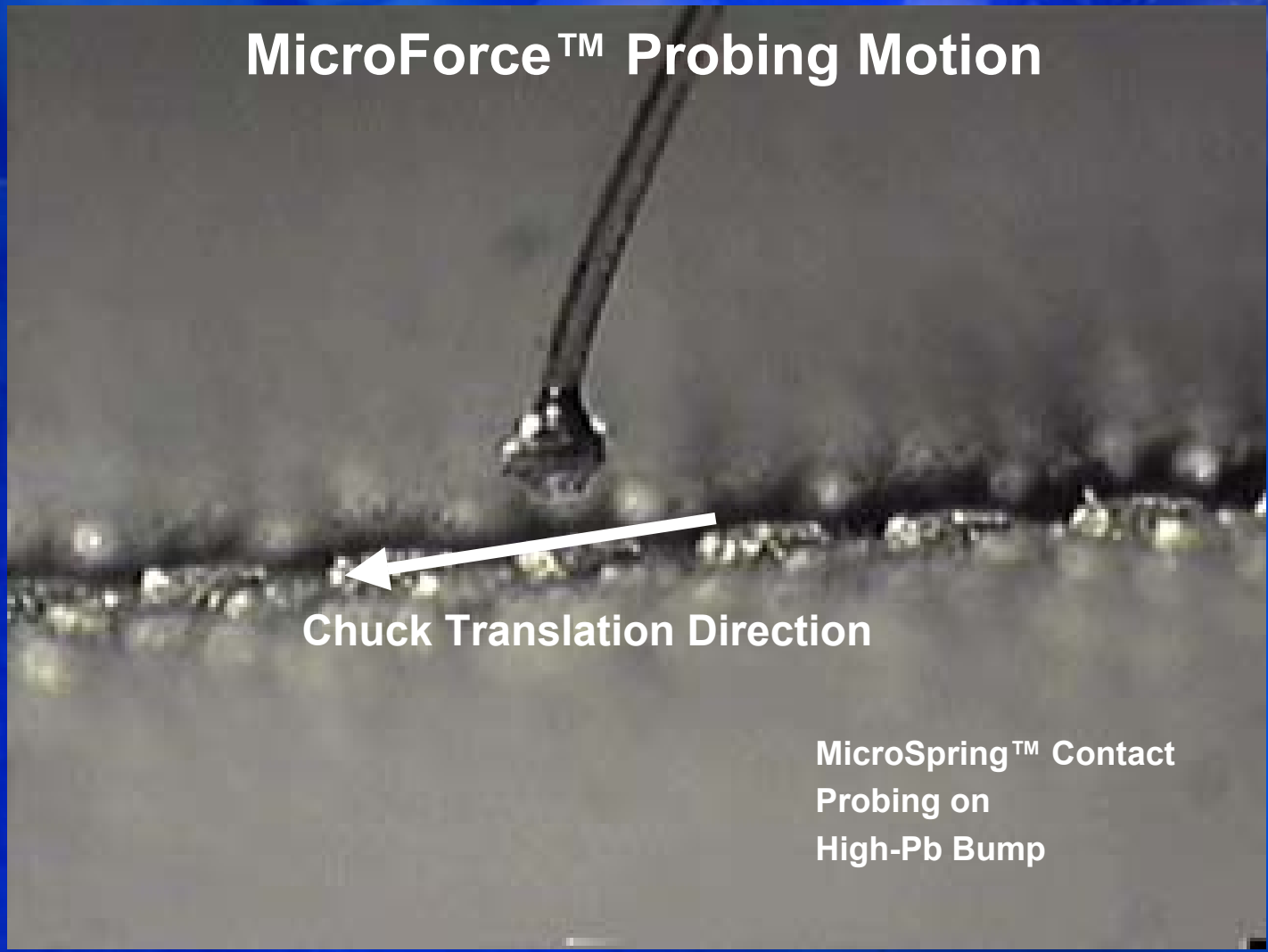
- What is MicroForce™ probing?
  - It is a coordinated X-Y-Z probing motion
  - Developed to satisfy a number of stringent requirements for probing devices with low-k ILD materials
  - Breakthrough results with 10:1 reduction of probe force yet achieving consistent and low contact resistance






1 – Prober Chuck Moves in Z-axis
2 – Contact with Flip Chip Bump
3 – Chuck moves in X-Y-Z

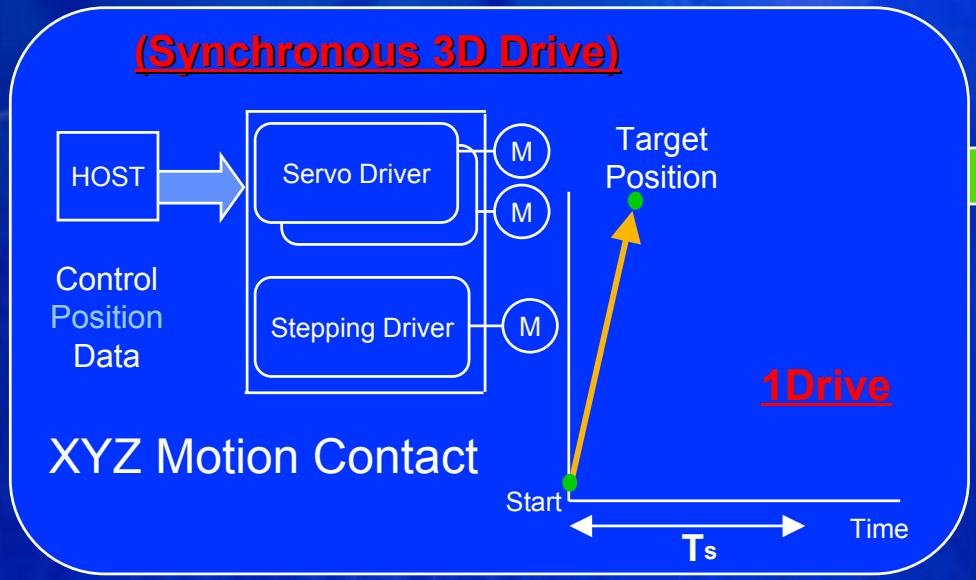
# MicroForce™ Probing on Pb/Sn Bump



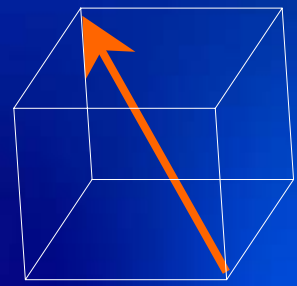
# FormFactor Laboratory Development


# TEL Synchronous XYZ Drive

## 3D drive control method



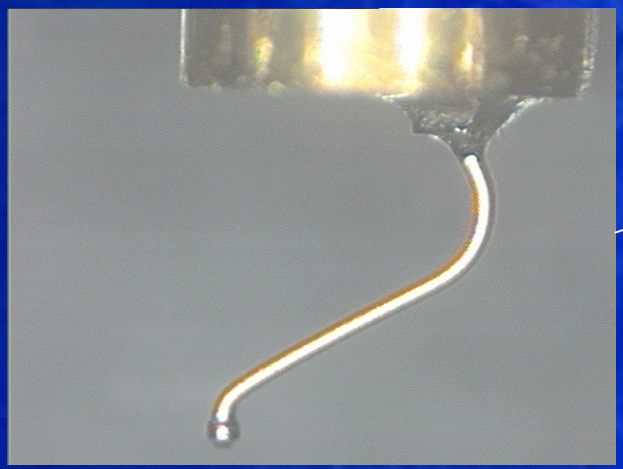

Simultaneous
XYZ Drive



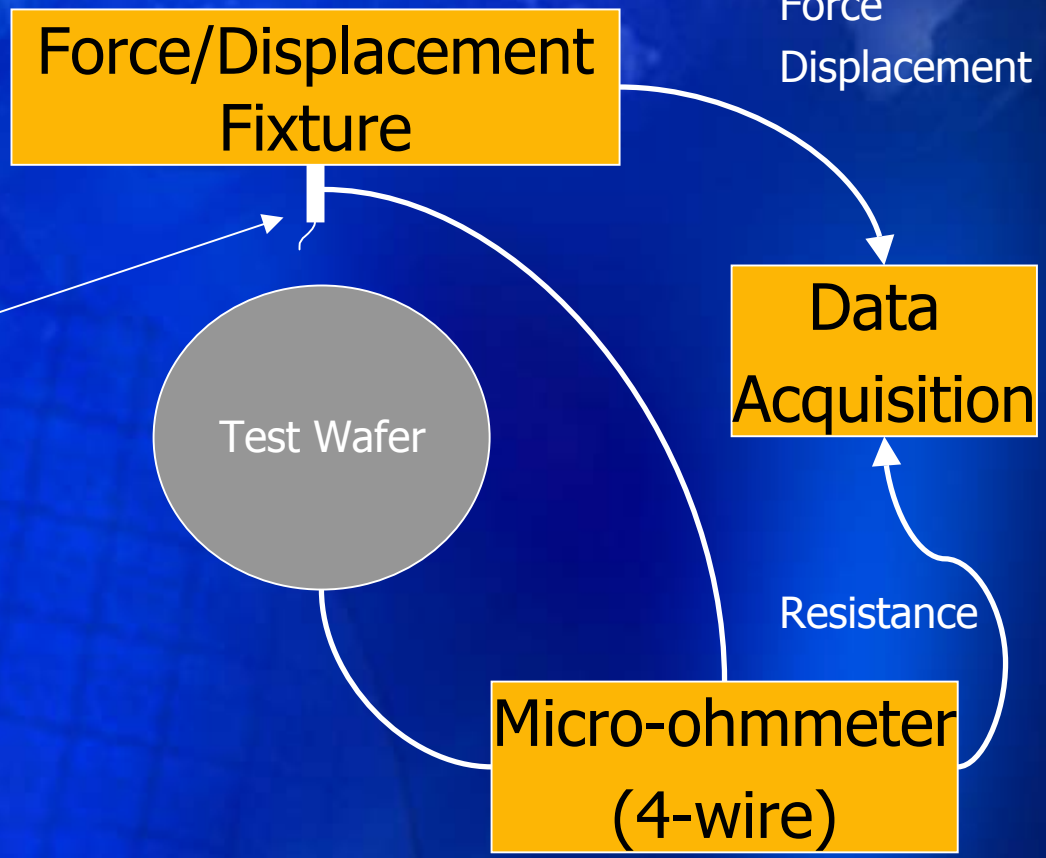
## Benefits

- **Increased throughput with simultaneous XYZ drive**
- **Smooth drive creates desired probe contact**

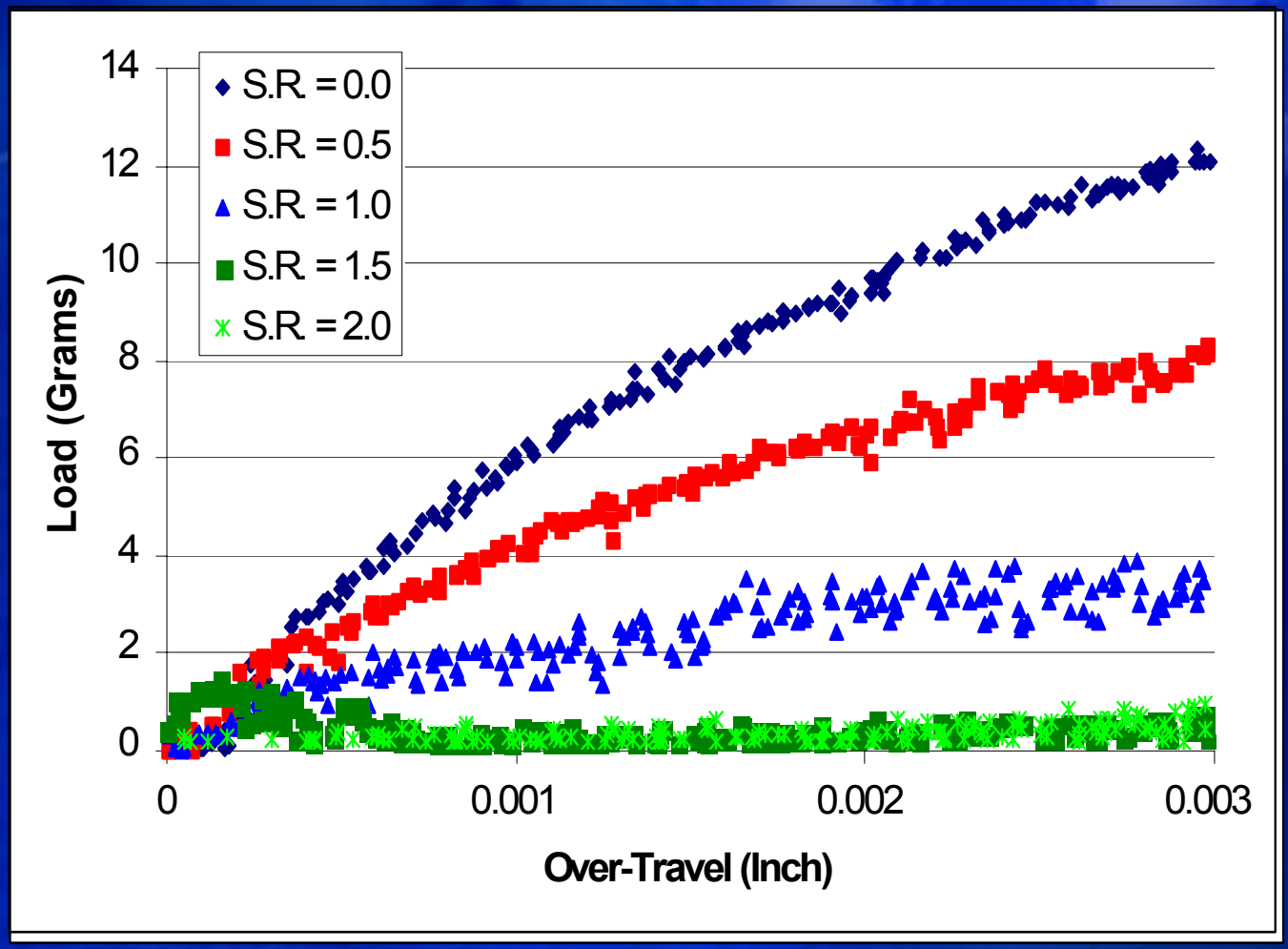
# Experimental Setup - Predictive Probing



Test Spring

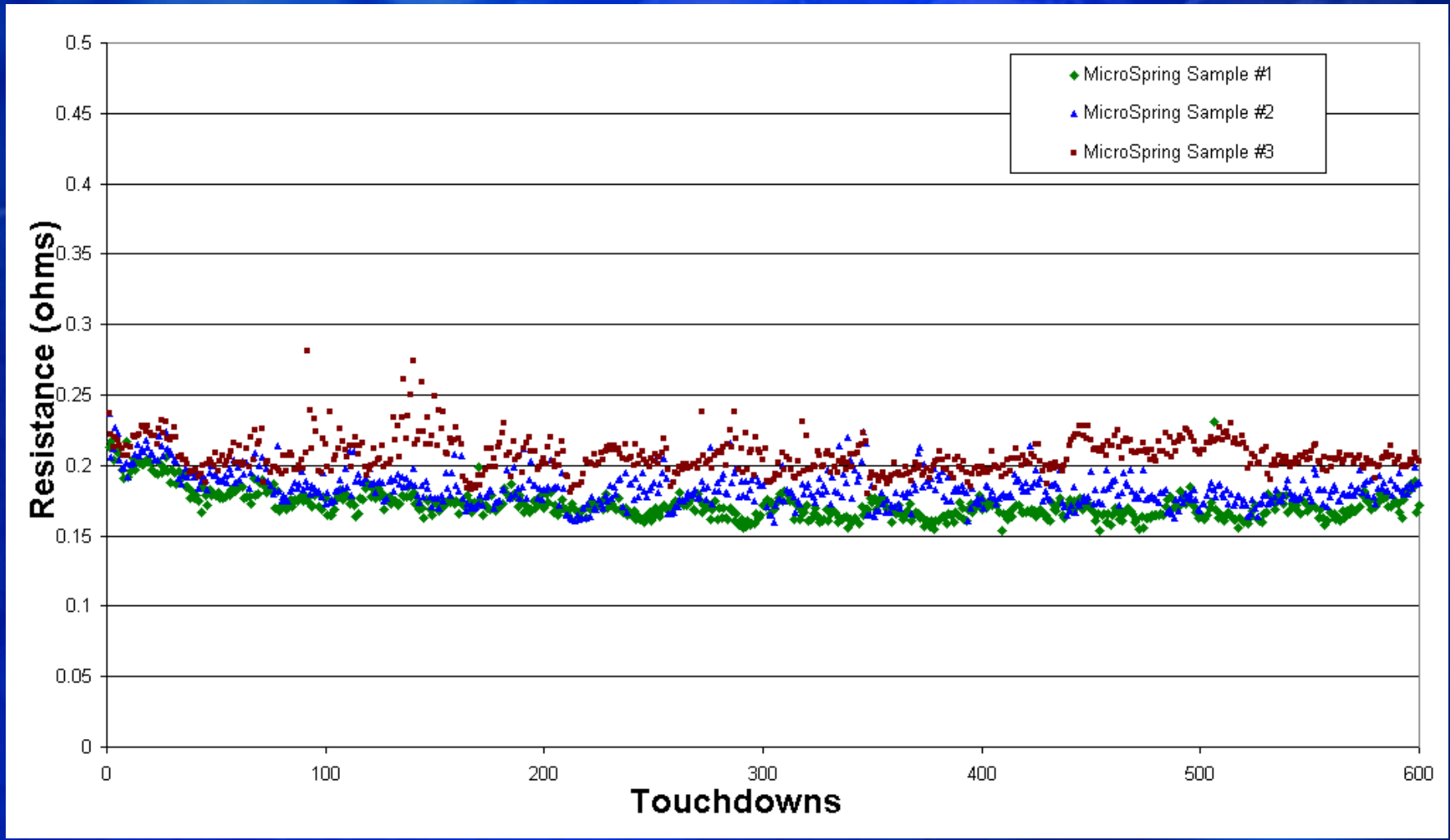


# Significantly Lowered Probe Force with MicroForce Feature




Scrub Ratio = Movement in X/Y / Movement in Z

# Repeatability of Cres Study on Pb/Sn Bumps




Stable and Low Contact Resistance with MicroForce Probing



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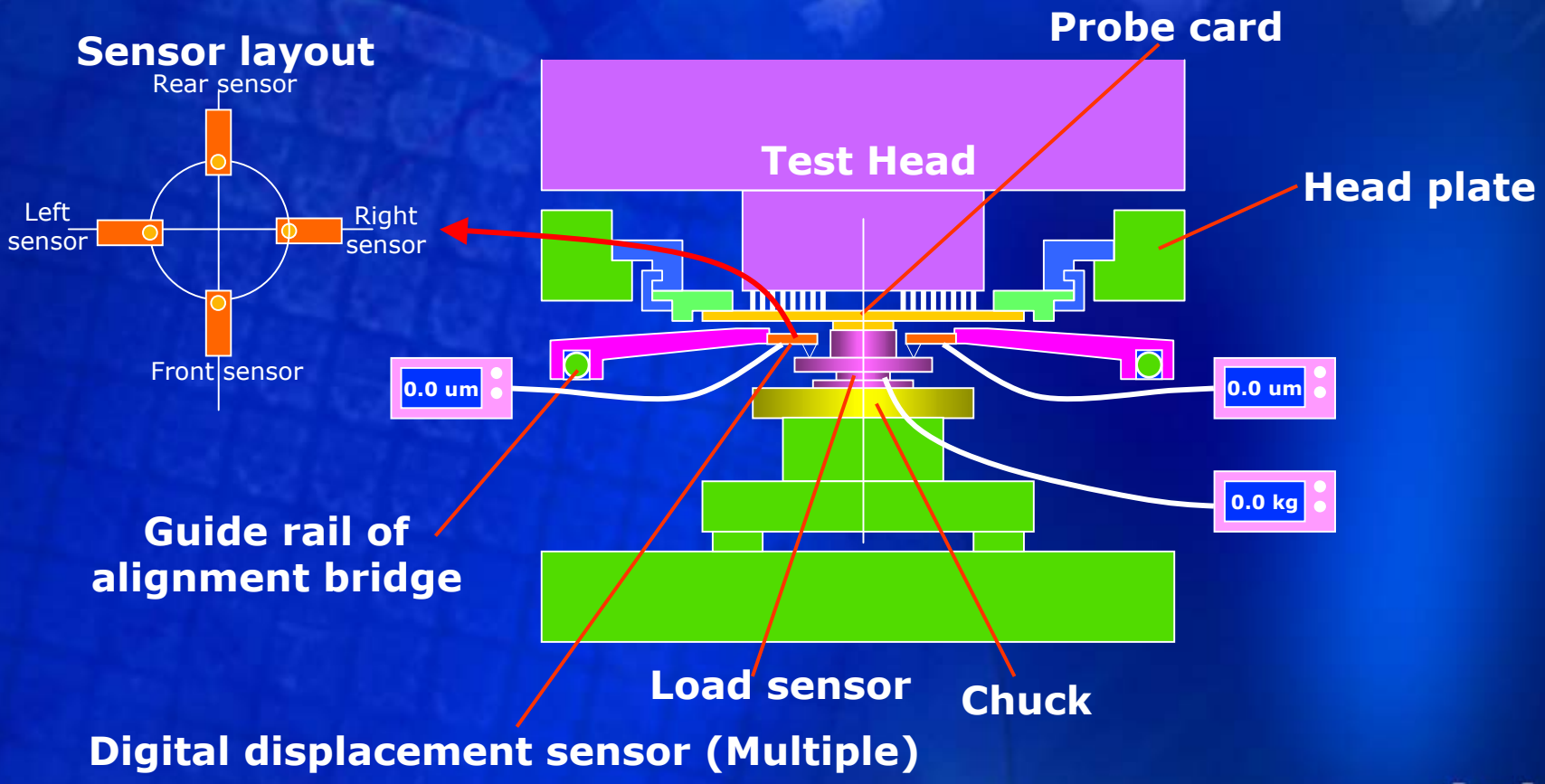
# Sort Floor Validation

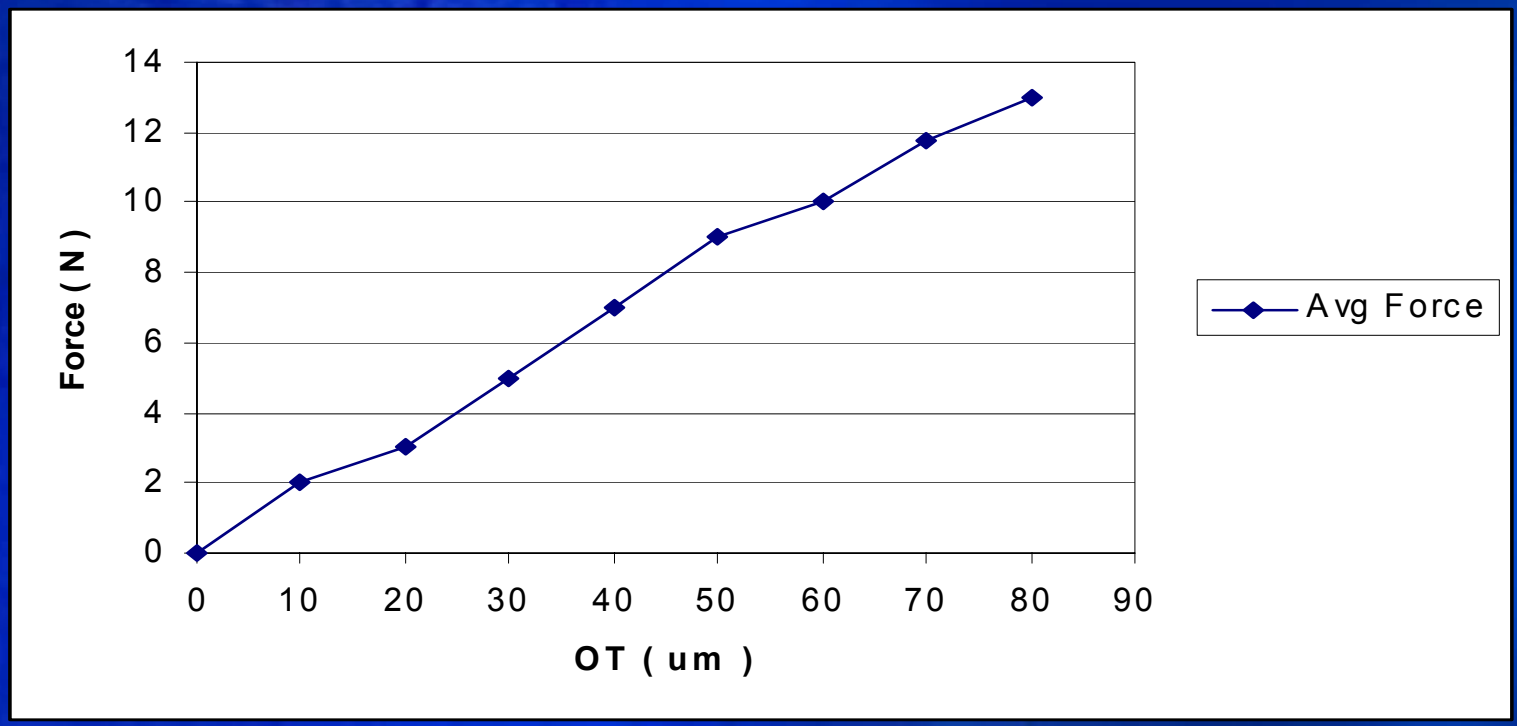

# Outline of Probe card Characteristics Measurement System

**Definition**
PCMS is a measurement system that can measure the probe card displacement under load.
The result of PCMS includes the displacement of head plate, probe card and probe card holder.



# Low Probing Force Using MicroForce Feature

- Used TEL's PCMS to evaluate probe card deflection under varying loads. Data generated included actual spring compression and probing force per dialed chuck motion.
- Max probing force = 13N at 80μm of spring over-travel
- Max force/probe = 0.3g/mil with MicroForce vs. 3 – 4g/mil without MicroForce

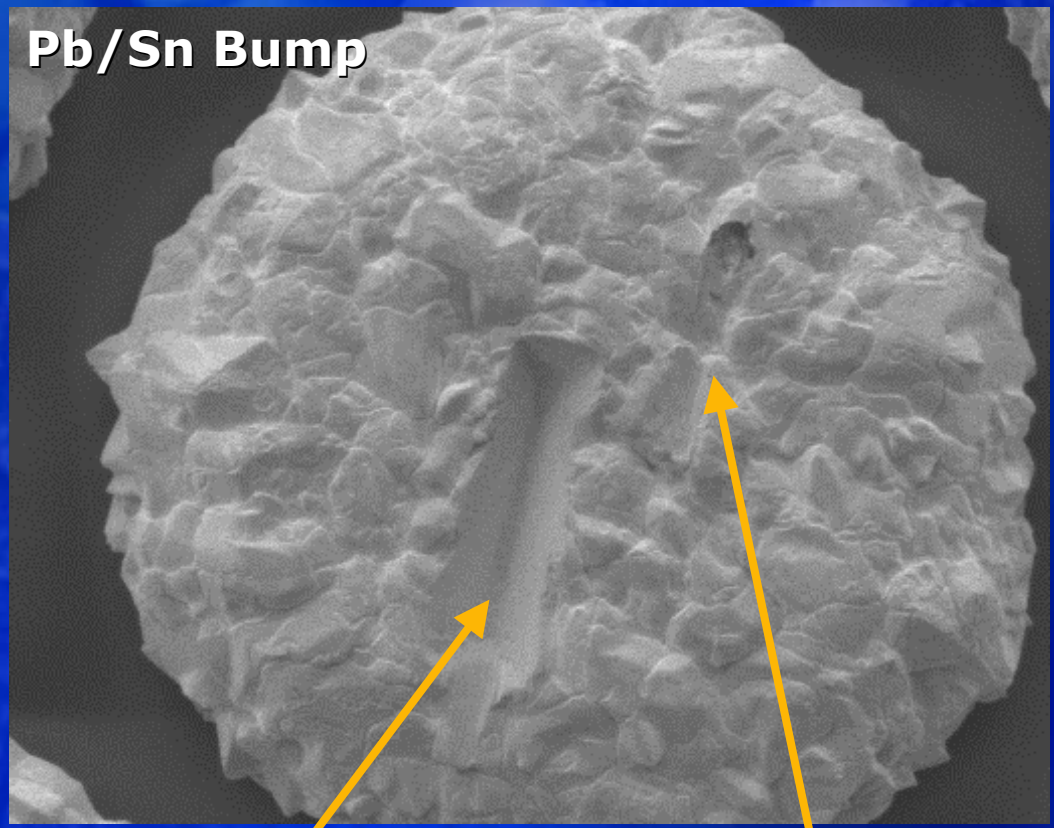


# Probing of Microprocessor Devices

- Testing
  - Sort tests were run with and without MicroForce probing
  - Correlation of device binning and other parametric indicators measured
  - 3 production lots of microprocessor devices were tested

- Results
  - Binning data collected under MicroForce had a correlation rate of 95.9 – 97.4% vs. existing probing Recipe (target is >95%)
  - Other parametric measurements indicated comparable results
  - No issues in terms of the mechanical and electrical behavior of the springs under MicroForce Probing. Metrology data remained within the defined specifications.

# Probe Mark Comparison



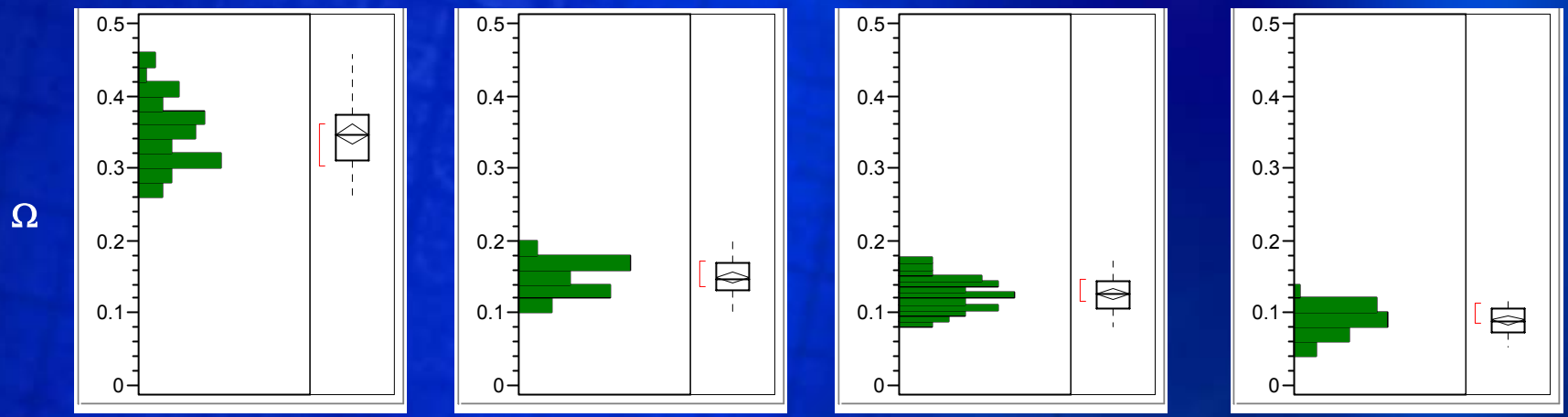

Standard Probing

MicroForce Probing

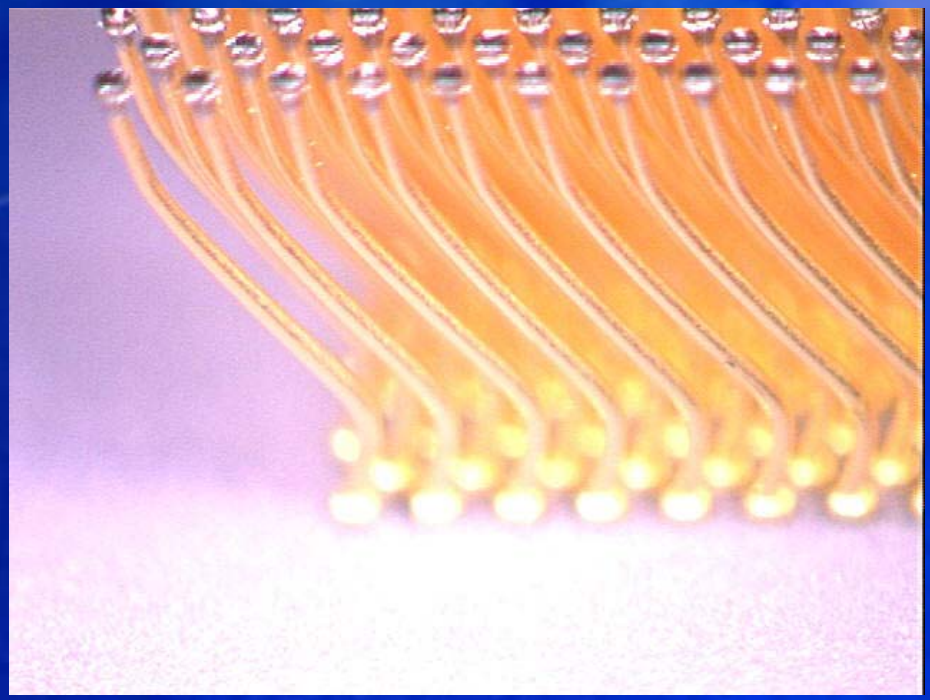
# Validation of MicroForce Low Cres

- Good convergence of Cres
- Mean Cres at different programmable ovetravels: 0.1 – 0.35Ω
- Enabling a wide manufacturing process window

| POT um | Mean | Std Dev |
|---|---|---|
| 15 | 0.3466 | 0.047 |
| 35 | 0.1492 | 0.023 |
| 50 | 0.1256 | 0.024 |
| 70 | 0.0898 | 0.020 |

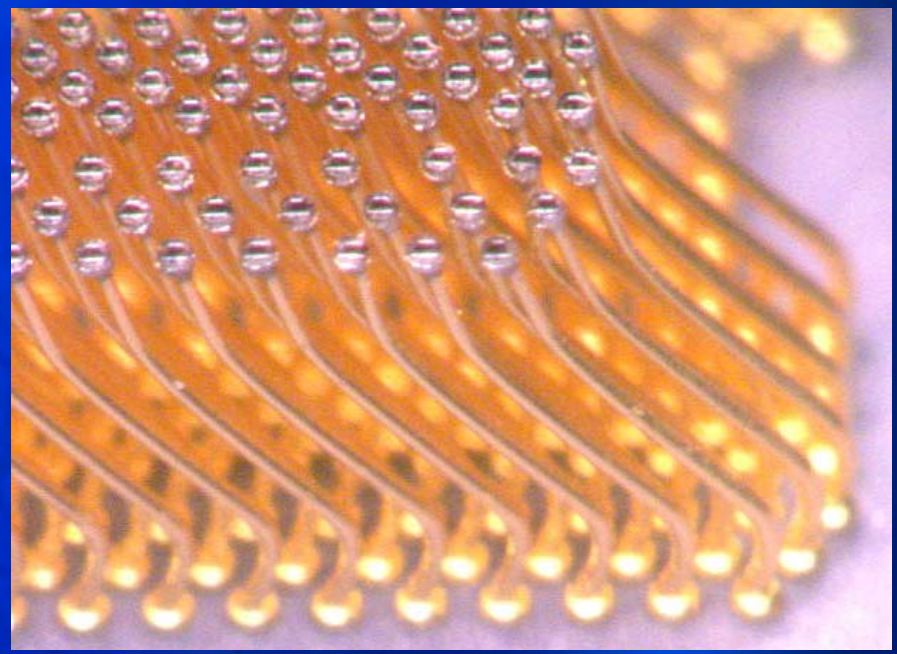


# MicroSpring Contact After Aging Test



New (after probing 6 wafers)

After 500,000 Touchdowns





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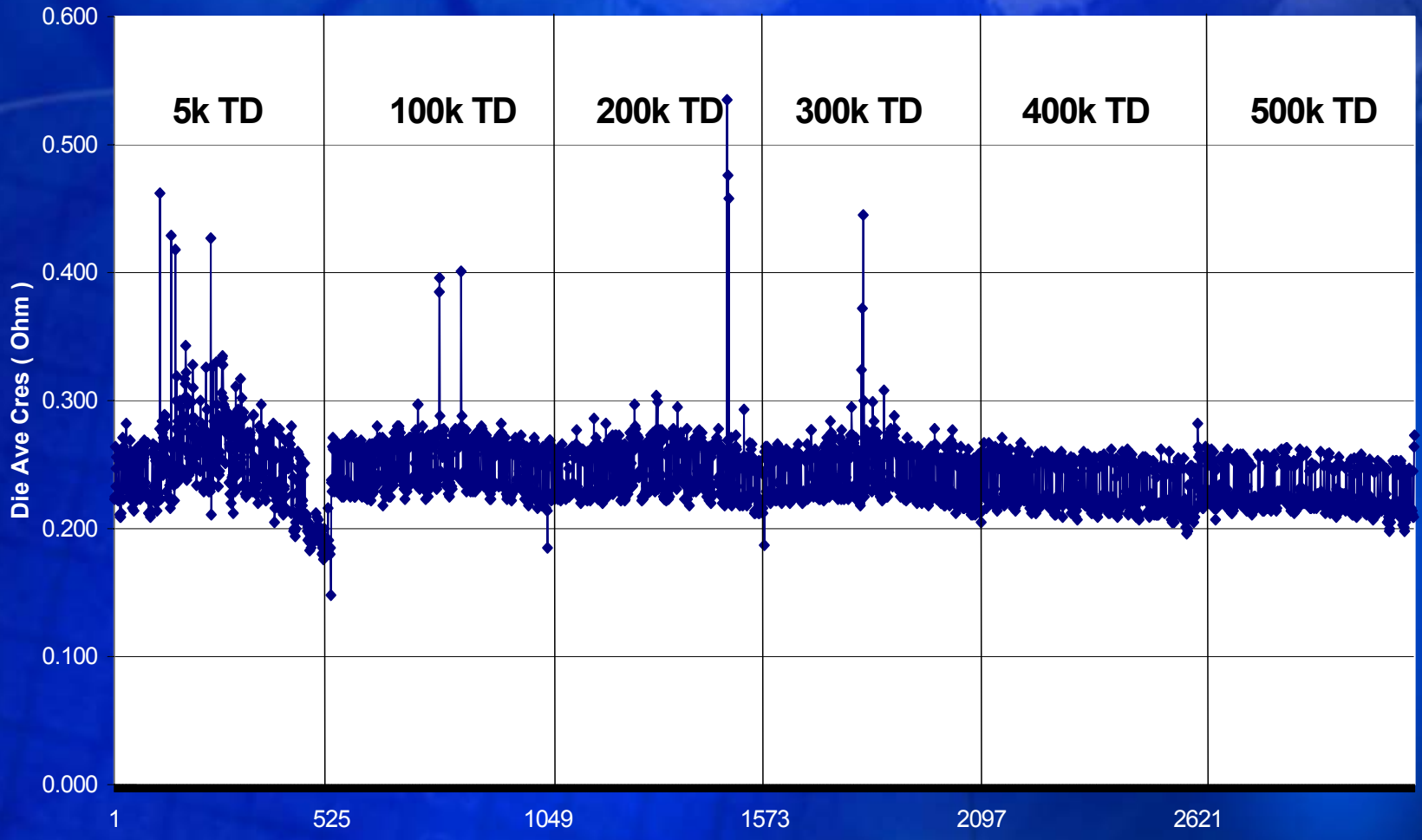
# Cres Stability After Aging Test

## Under MicroForce Probing, Cres remained stable for 500K touchdowns



# Conclusions

- MicroForce Technology provided new capabilities to meet new-generation probing requirements.
- MicroForce Probing offered low contact resistance necessary for high power delivery requirements.
- MicroForce Probing delivered very low probing force (<2g) thus minimizing the risk to damage die with low-k ILD materials.
- Sort on production devices proved very stable and correlated to existing probing recipes. The solution satisfies Intel probing requirements.
- Future work will be targeted at:
  - Throughput Optimization
  - Production Sort Certification

# Acknowledgment

**The authors would like to thank the following contributors who made the MicroForce Probing development possible:**

| | |
|---|---|
| Tim Cooper | FormFactor |
| Gene Kochert | Intel |
| Koichi Matsuzaki | TEL |
| Lance Milner | Intel |
| Jesse Nuanez | Intel |
| Weida Qian | Intel |
| Scott Scofield | Intel |
| Rick Takebuchi | TEL |
| Dilip Wadhwani | Intel |
| Sunil Wijeyesekeara | FormFactor |