



# SW Test Workshop

Semiconductor Wafer Test Workshop

June 7 - 10, 2015 | San Diego, California

## Review of New, Flexible MEMS Technology to Reduce Cost of Test for Multi-site Wire Bond Applications

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**TEXAS INSTRUMENTS**



**FORMFACTOR INC.**

# Overview

- **Project Background & Objective**
- **Probe spec - FFI**
- **Data Results - TI**
  - Planarity
  - Thermal agility
  - Pad damage
  - Cres performance
  - Yield performance
  - Life time data
- **Summary**

# Background

- **Previously evaluated and released to production a new MEMS vertical technology for flip chip bumps**
  - Results presented at SWTW 2014 (S07\_01\_Stillman\_5-28-2014)
- **For wire bond applications, wanted to combine the strong operational performance of MEMS cantilever technology with the pad layout flexibility and repair – ability of MEMS vertical technology**
- **Leverage success of production worthiness of flip chip applications to expand design coverage for wire bond applications**

# Motivation From Previous Work

- **Conclusion from 2014 SWTW presentation**

- Low-force MEMS Probe Card Technology, such as FormFactor's K-Probe, demonstrated several advantages for solder flip-chip probing in high-volume production
  - Production stability for high pin counts, > 20,000 pins
  - Scalability for multi-DUTs probing,  $\geq 8$  DUTs
  - Long life-time, >2M touchdowns demonstrated
  - Controlled Cres in production
- As flip-chip pitch continues to shrink, requiring finer vertical probes, MEMS probe technology is proven to be a viable path to continue lowering cost of test

- **Extend the MEMS vertical spring technology to Al pad probing for wire bond applications**

# Project Objective

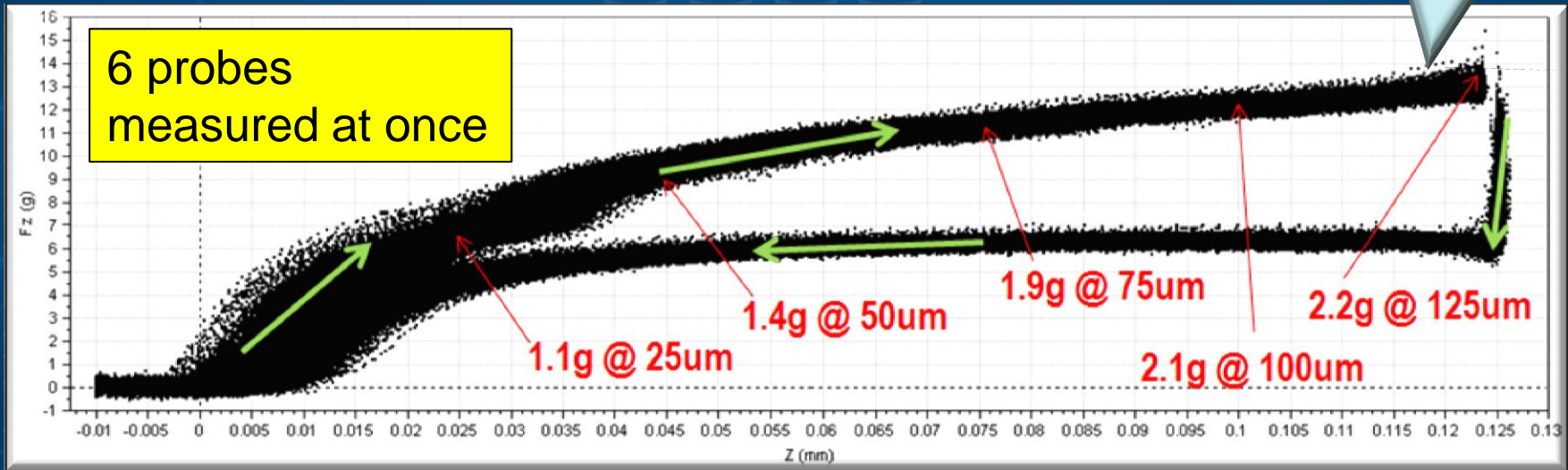
- **Evaluate, then release to production a new MEMS vertical probe technology for AI pads**
  - Low force probe without sacrificing CCC
  - Contact stability – tight planarity and CRES
  - Thermal Agility –probe card stability with wide temperature range of -40°C to 140°C
  - Minimal pad damage and ILD cracking
  - Production support with field replaceable probes



# Basic Spring Performance

## Probe Force vs. Over Travel

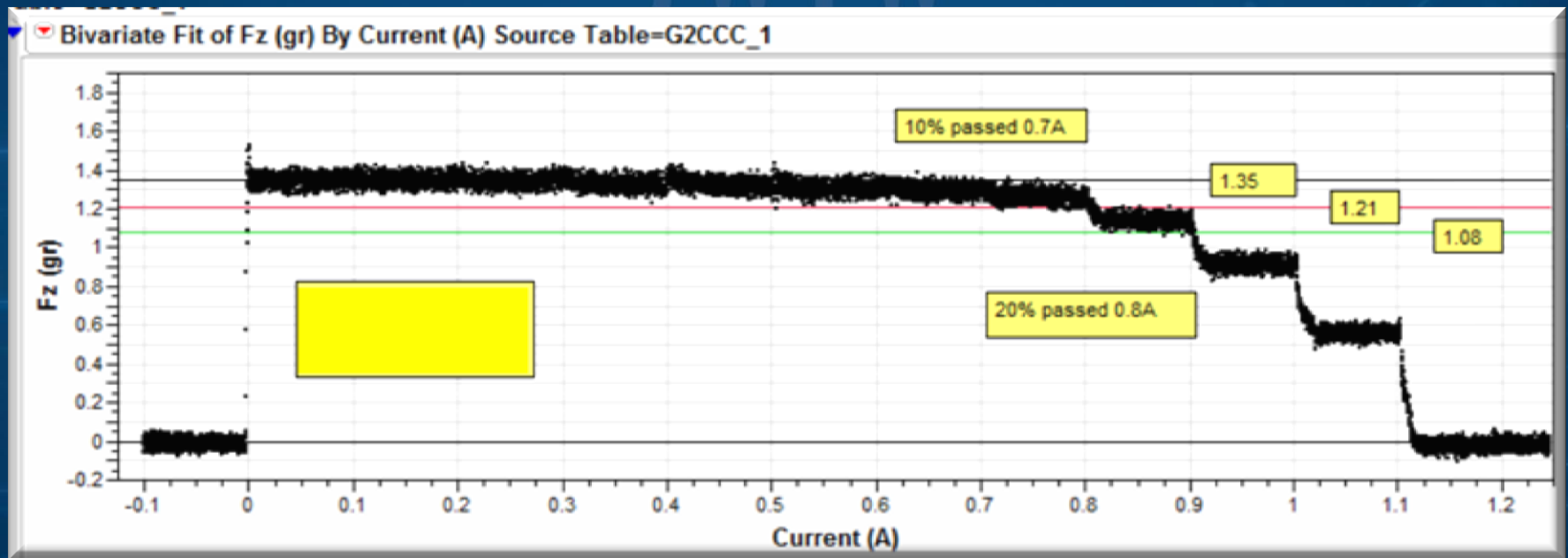
Full Probe cycle of being compressed and released



Data after 1.5M cycles

# Basic Spring Performance

ISMI Current Carrying Capacity  
performance of low force vertical spring



Data after 1.5M cycles

# Qualification Results

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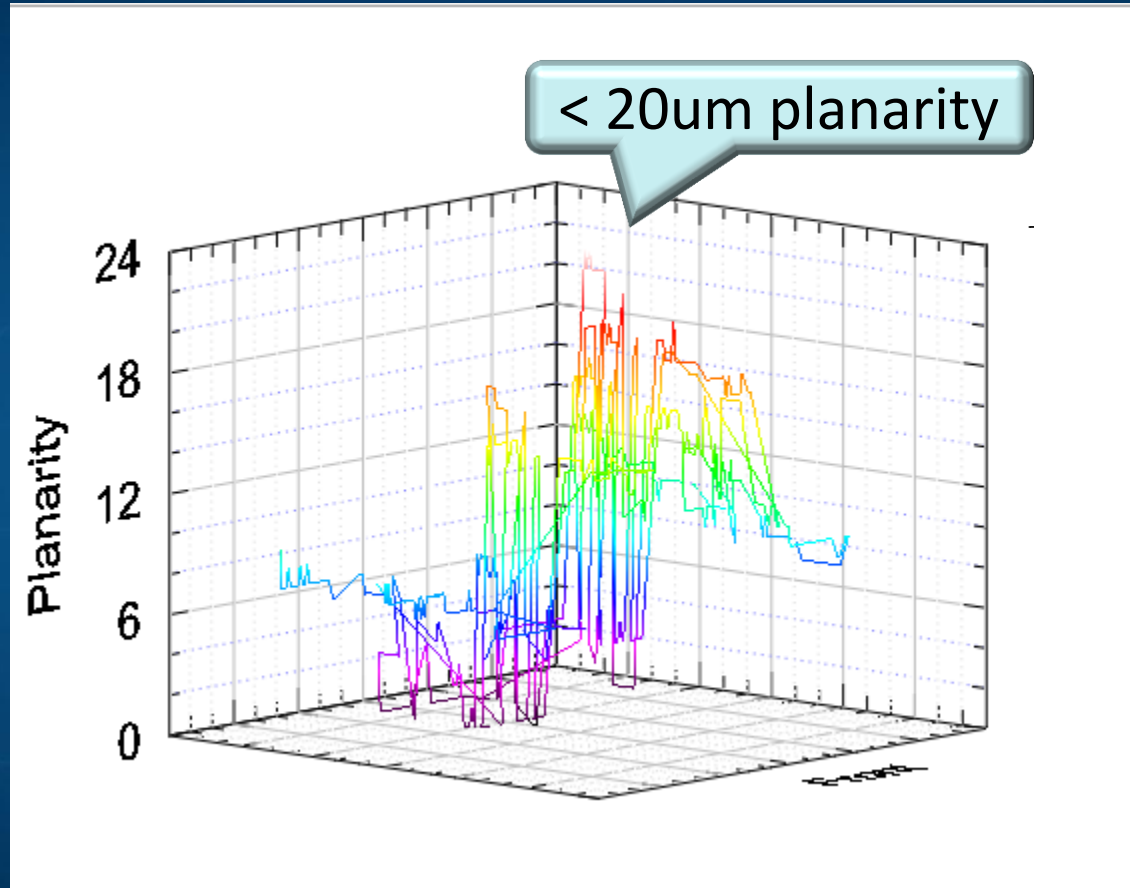
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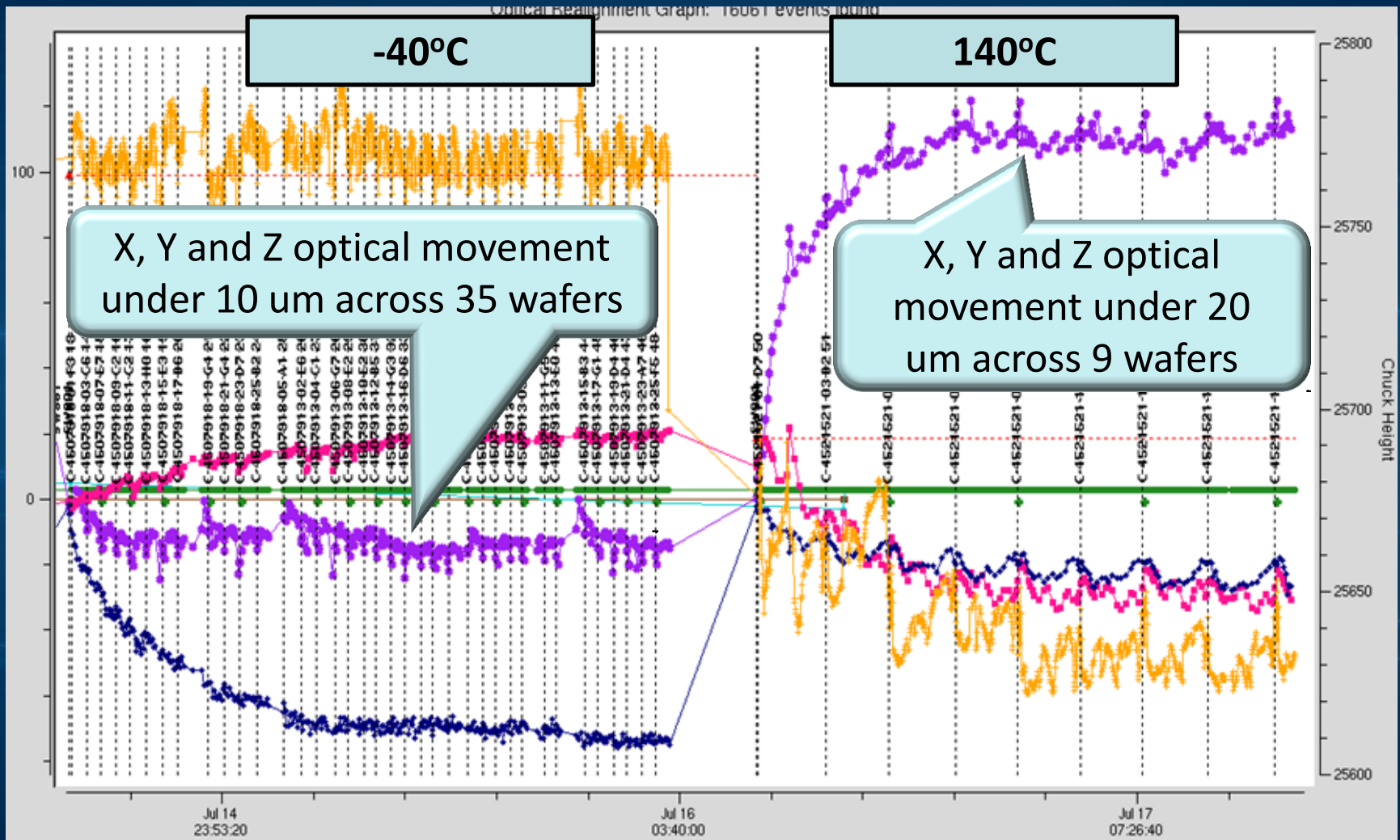


# Auto Z Performance



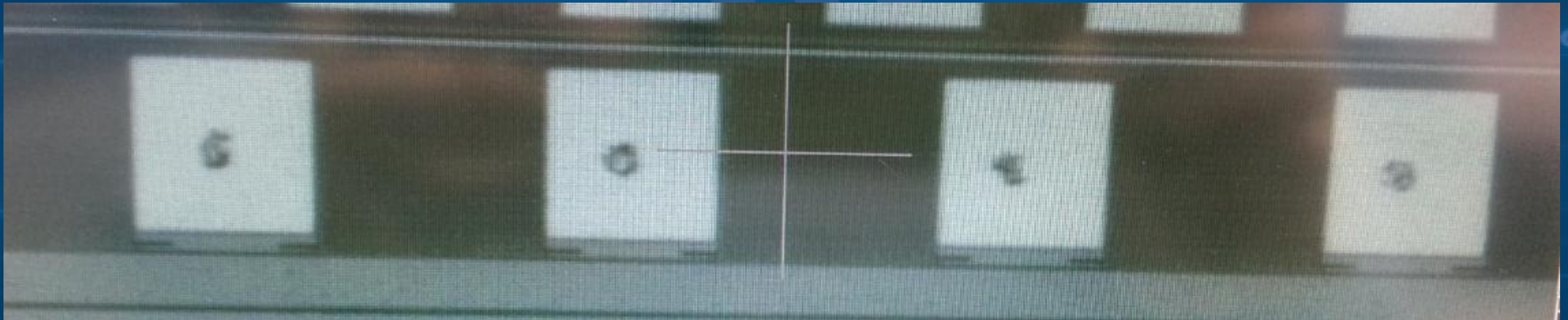
- Probe card layout – x8, 1256 springs, 608 mm<sup>2</sup> array

# Thermal Agility



- **Once the card gets to temp, thermal movement is very stable**

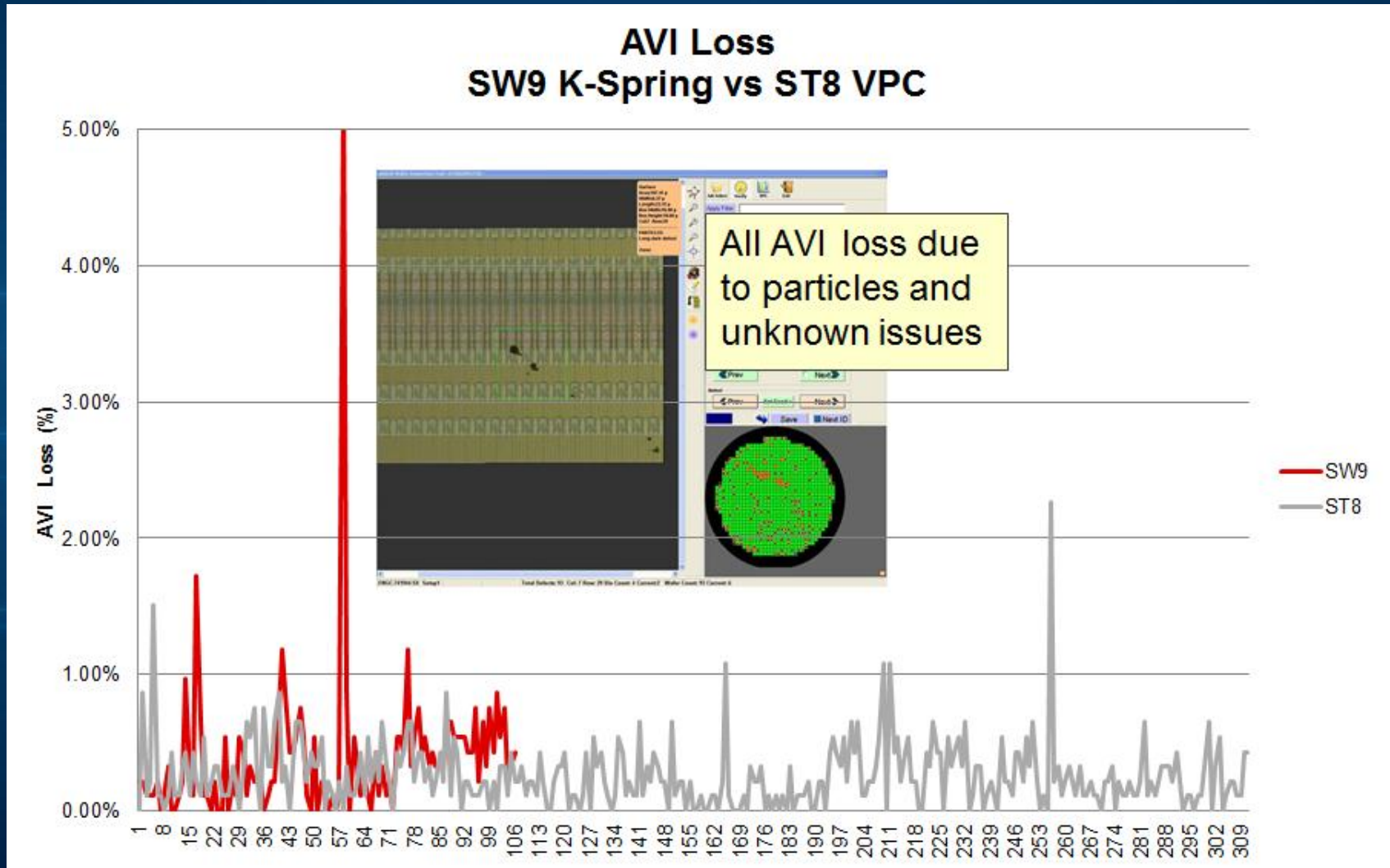
# Minimal Pad Damage



- Probing at 80um OT

# AVI Performance

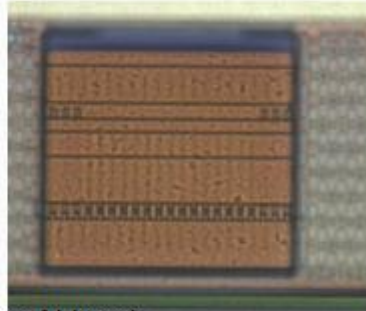
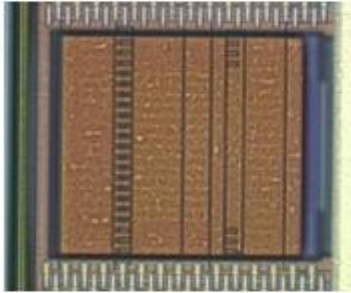
## (Automated Visual Inspection of Pad Damage)





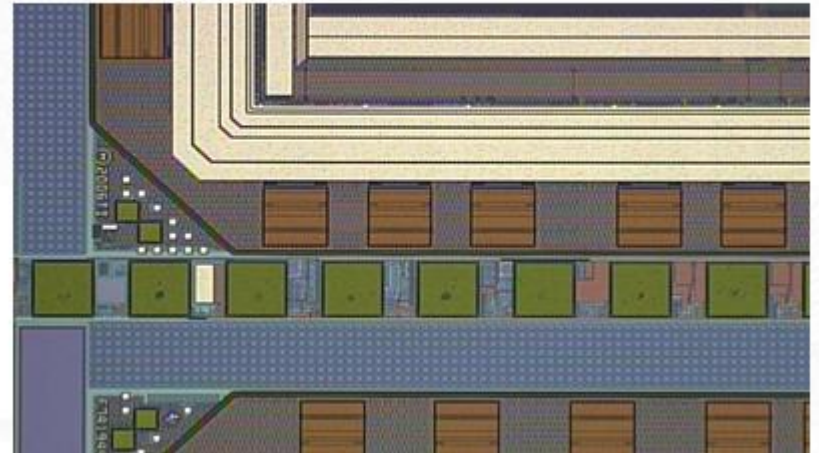
# Dielectric Cracking & Punch Through

## 11x Touchdowns at 100um OT



Pad structure after Al leach  
No dielectric cracking found

## Parametric cracks found during wafer de-processing.

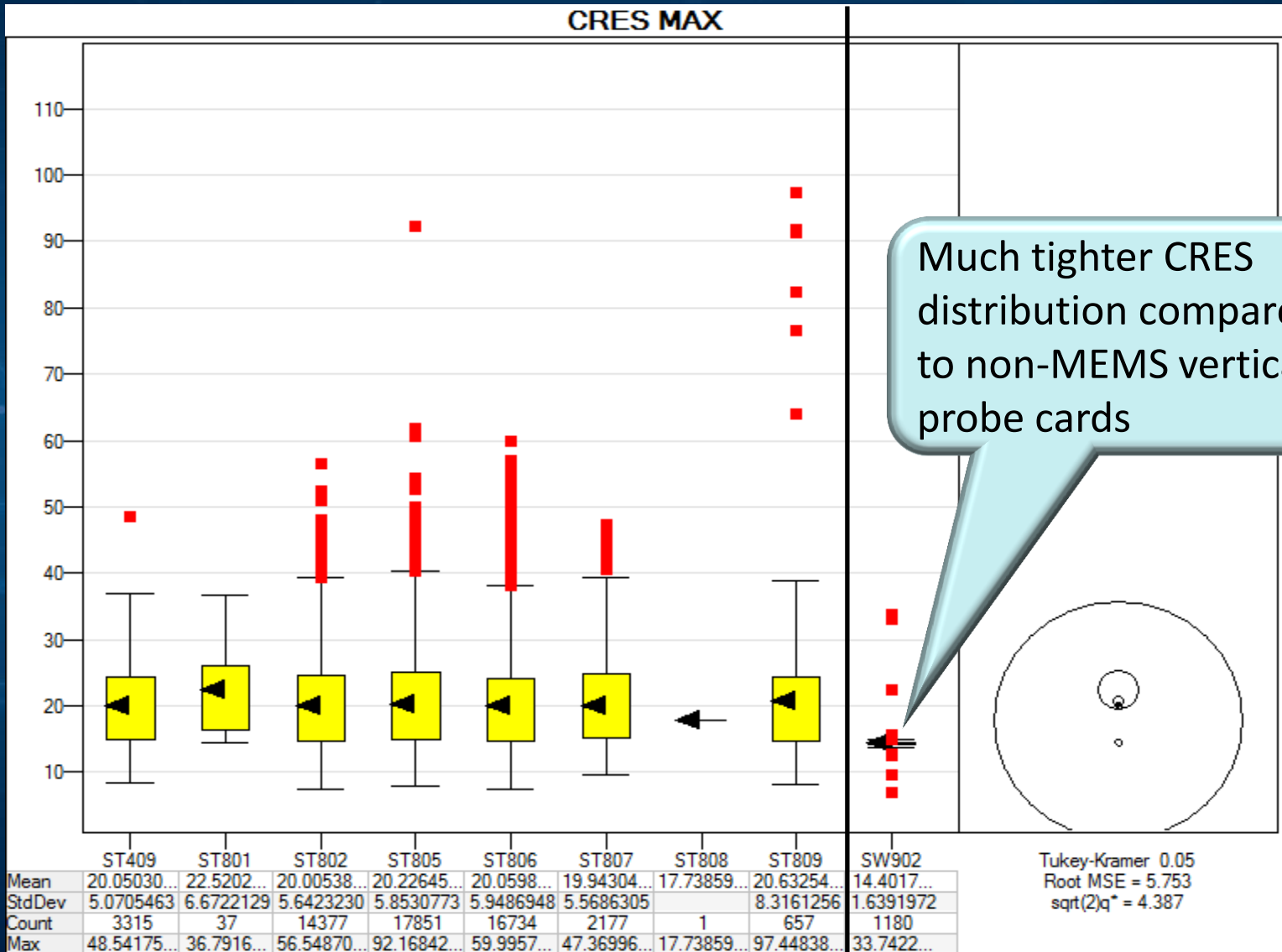


## Punch Through per TD count

TD Count	Punch through found	Raw punch through per parts per million
3x – 10x	NA	NA
11x	0	0

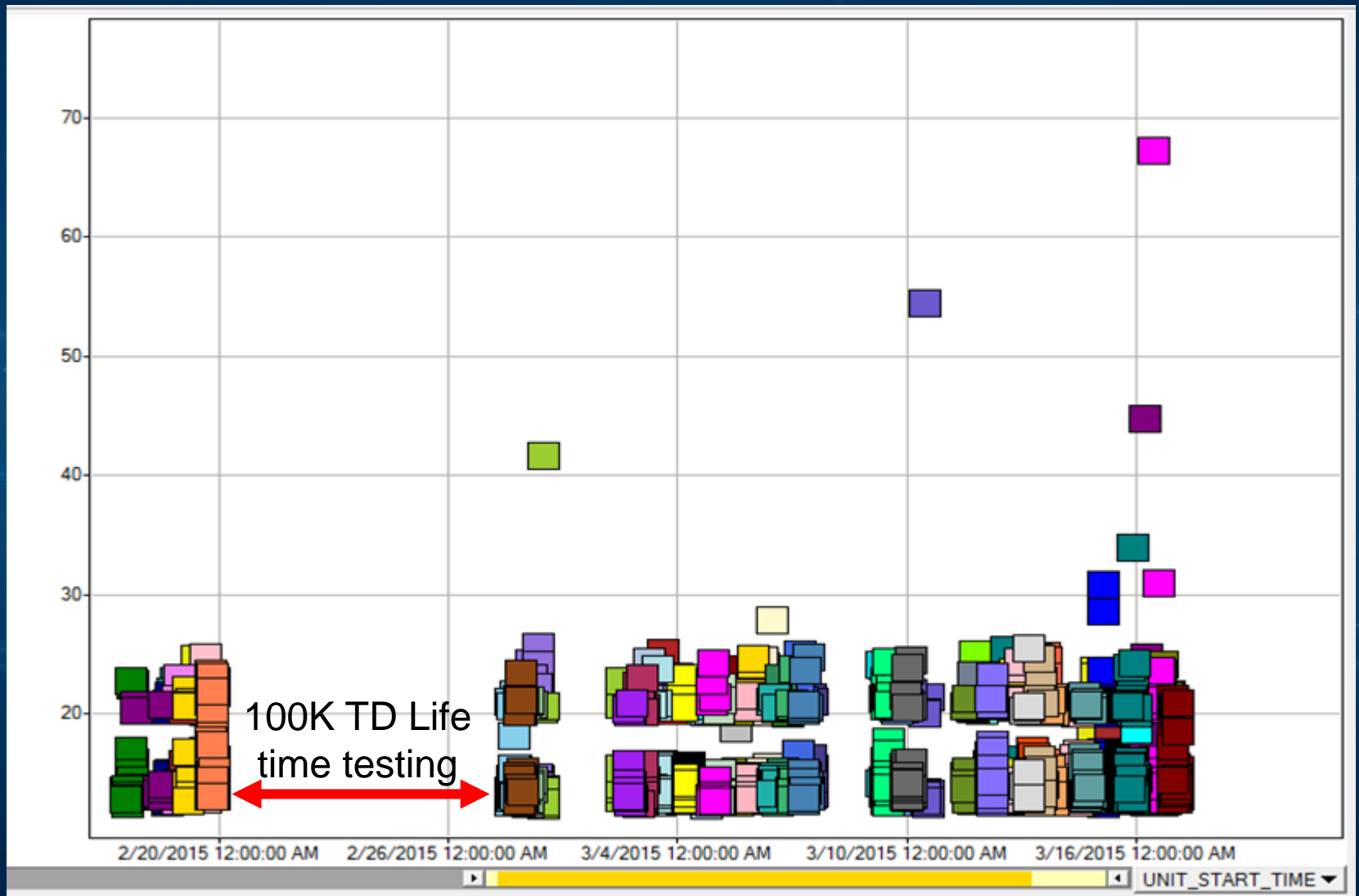
Results: No dielectric cracking found with 100um OT on F05 Saturn 60 wafers - Pass

# Max CRES – Production Data

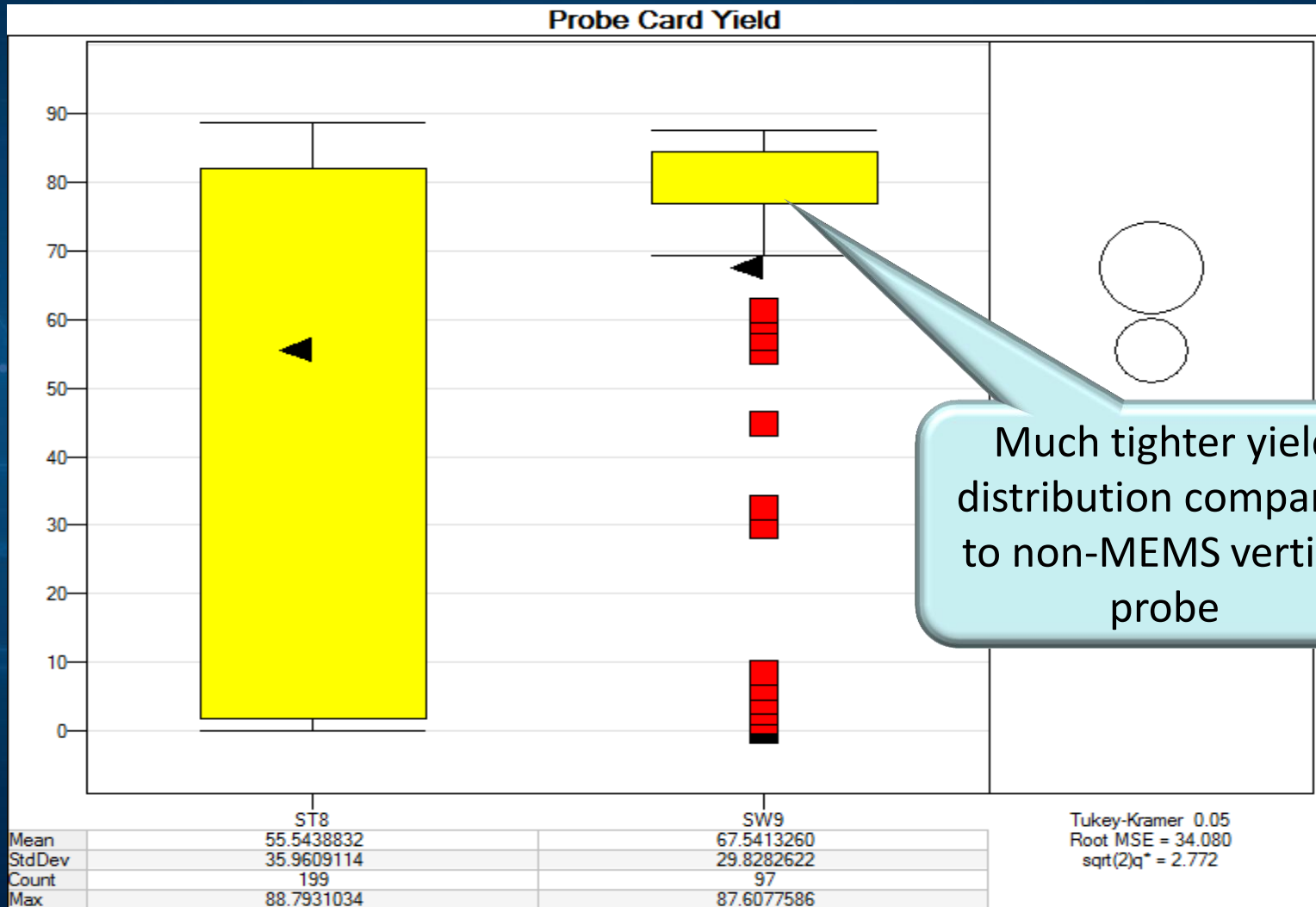




# CRES Over Time

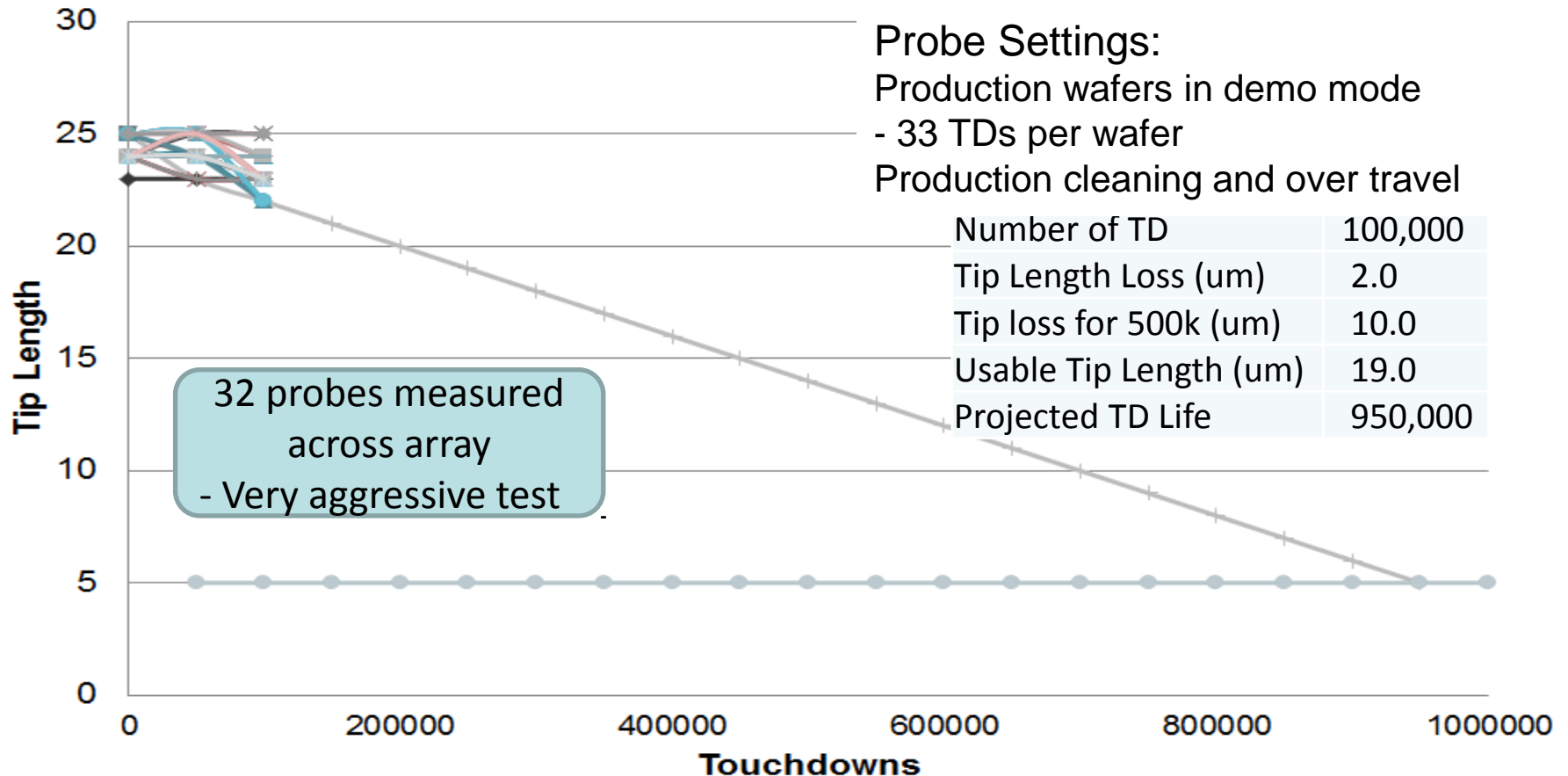


# Yield Comparison



# Life Time Data

## K Spring Life Time Test



- Initial projects of ~1M TD lifetime in production

# Summary

- **Production performance stand out**
  - Production performance
    - Planarity
    - Thermal agility over wide temperature range
    - Minimal pad damage, stable AVI and no ILD cracking
    - CRES and Yield
    - Lifetime
- **Compelling new technology to replace existing high volume technologies**
- **Flexible MEMS Technology to Reduce Cost of Test for Multi-site Wire Bond Applications**

# Acknowledgement

- Al Wegleitner, Texas Instruments
- Frank Meza, FormFactor
- Doug Shuey, FormFactor
- Kevin Hughes, FormFactor

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