

# IEEE SW Test Workshop

Semiconductor Wafer Test Workshop



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## Reducing the Cost of Test on Gold & Copper Pads

Seagate



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# Overview

- **Problem Definition**
- **Current Status**
- **Improvement Results**
- **Conclusions / Recommendations**
- **Acknowledgments / References**



# Problem Definition

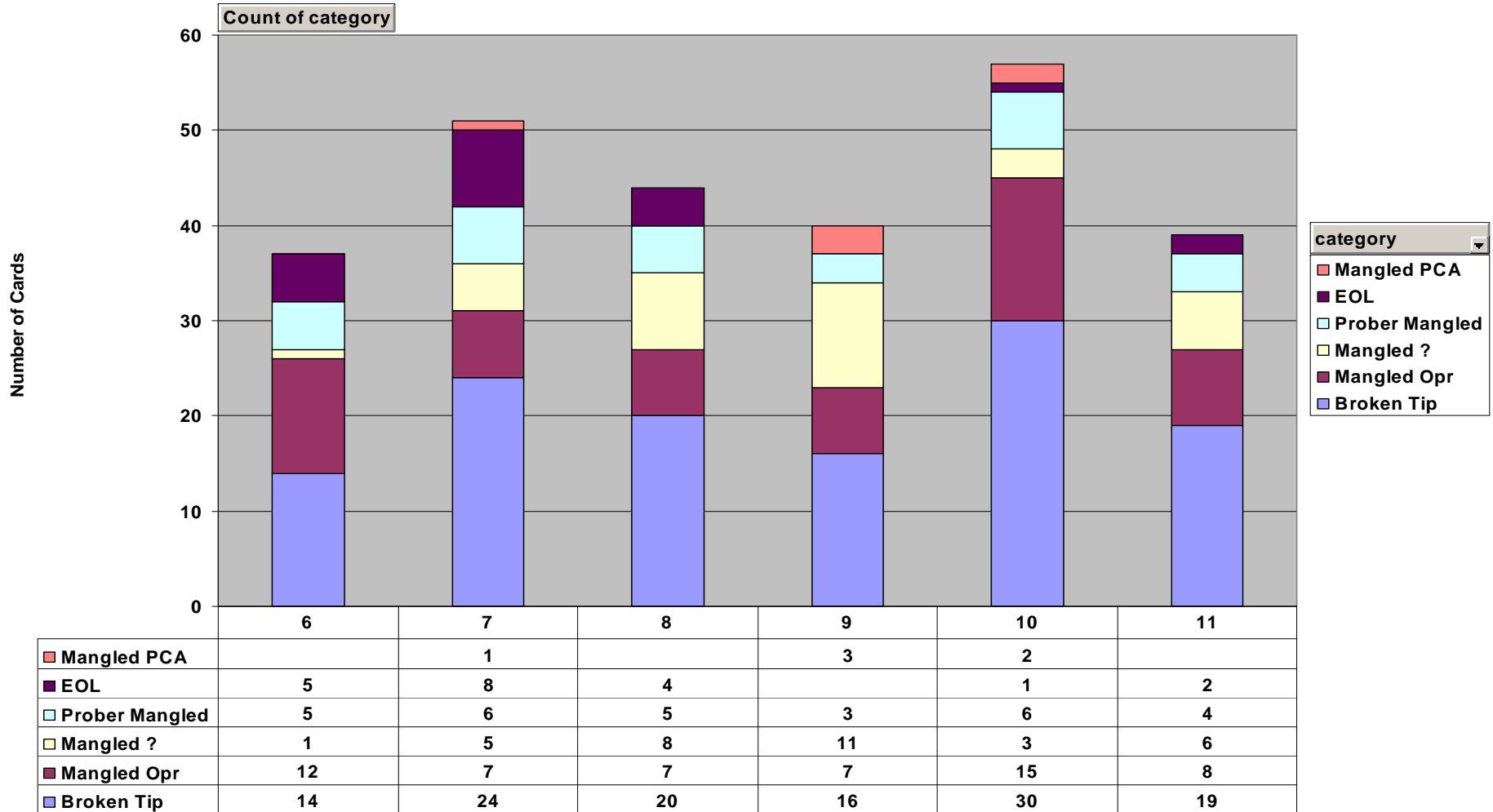
- Historically we used Beryllium Copper (BeCu) probe material for testing on our Gold (Au) and Copper (Cu) pads due to its low contact resistance capability.
- With decreasing pad pitch (45uM) and thus more complex card designs, the probes were naturally becoming smaller and less stable. This carried a cost in terms of -
  - Reduced probe card lifetime
  - Increased operator maintenance
  - Resulting in increased spend.



# Card Failure Categories

FW (All)

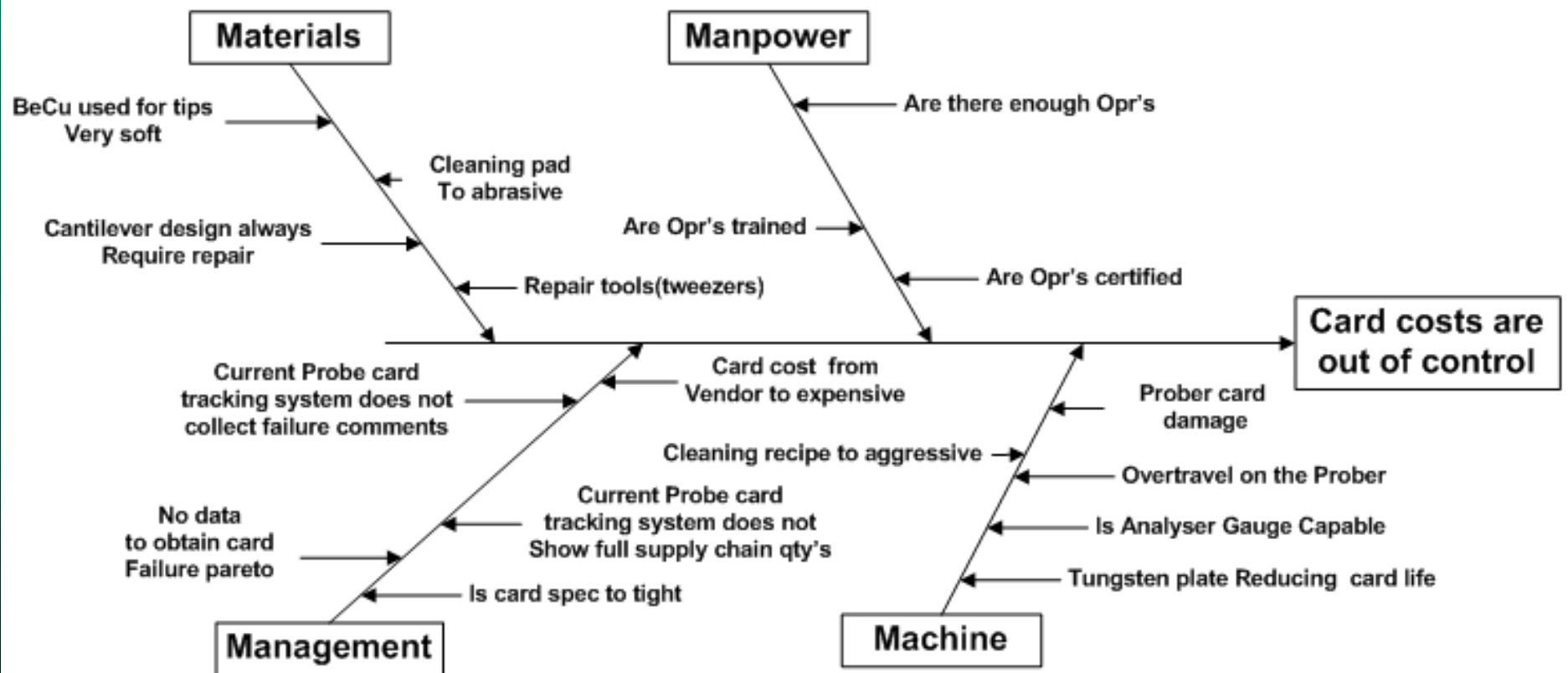
*At this stage we regarded EOL as 1.5MTDS*



Month



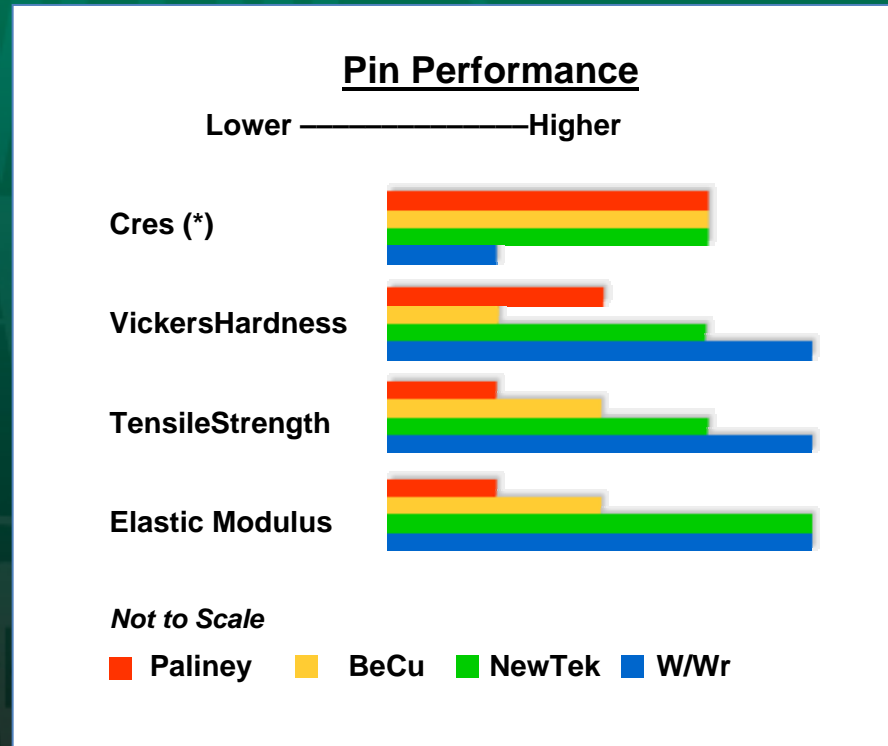
# Cause & Effect – Card Costs



# Material Selection & Comparison

- **Material Selection priorities:**

- Extend card lifetime
- Sort Yield
- Sort Retest Level



\*Courtesy of Advanced Probing Systems Inc.

- **This involved taking a close look at various on-line cleaning solutions, different probe materials and controlling the amount of needle aligning.**



# Material Selection & Comparison

PROPERTY	Tungsten	Tungsten Rhenium	Beryllium Copper	Paliney 7 <sup>®</sup>	NewTek VerTek
<i>Electrical and Thermal Properties:</i>					
Bulk Resistivity at 20°C (mohm-cm)	5.59 to 5.86	9.15 to 9.65	6.10 to 7.93	30.9 to 34.9	55.1 to 58.2
Melting Point (°C)	3410	3410	870 to 980	1015	1300 to 1350
Coeff. of Lin. Exp. (0 to 500 °C) (mm/mm ×1/°C)	4.45 ×10 <sup>-6</sup>	4.45 ×10 <sup>-6</sup>	17.8 ×10 <sup>-6</sup>	13.5 ×10 <sup>-6</sup>	7.6 ×10 <sup>-6</sup>
<i>Material Properties:</i>					
Elastic Modulus (GPa)	394.5±6.1	395.7±6.4	131.5±5.5	121.2±4.9	179 to 181
Tensile Strength (GPa)	2.65 to 2.90	2.90 to 3.36	1.28 to 1.31	0.90 to 1.25	1.30 to 1.55
Vicker's Hardness (100*Gourtesy of Advanced Probing Systems Inc) (kg/mm <sup>2</sup> )	288 to 300	290 to 310	128 to 384	320 to 357	382 to 438

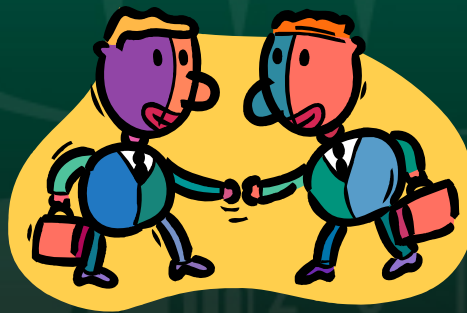


# Material Selection / Comparison Chart

- Initially we experimented with probe materials and continued to use our Probe Polish 99 (ITS) cleaning material.

– NewTek

– WRe



- The long term trial was started using 3 WRe probe cards and Probe Polish 99 (ITS) cleaning Material.

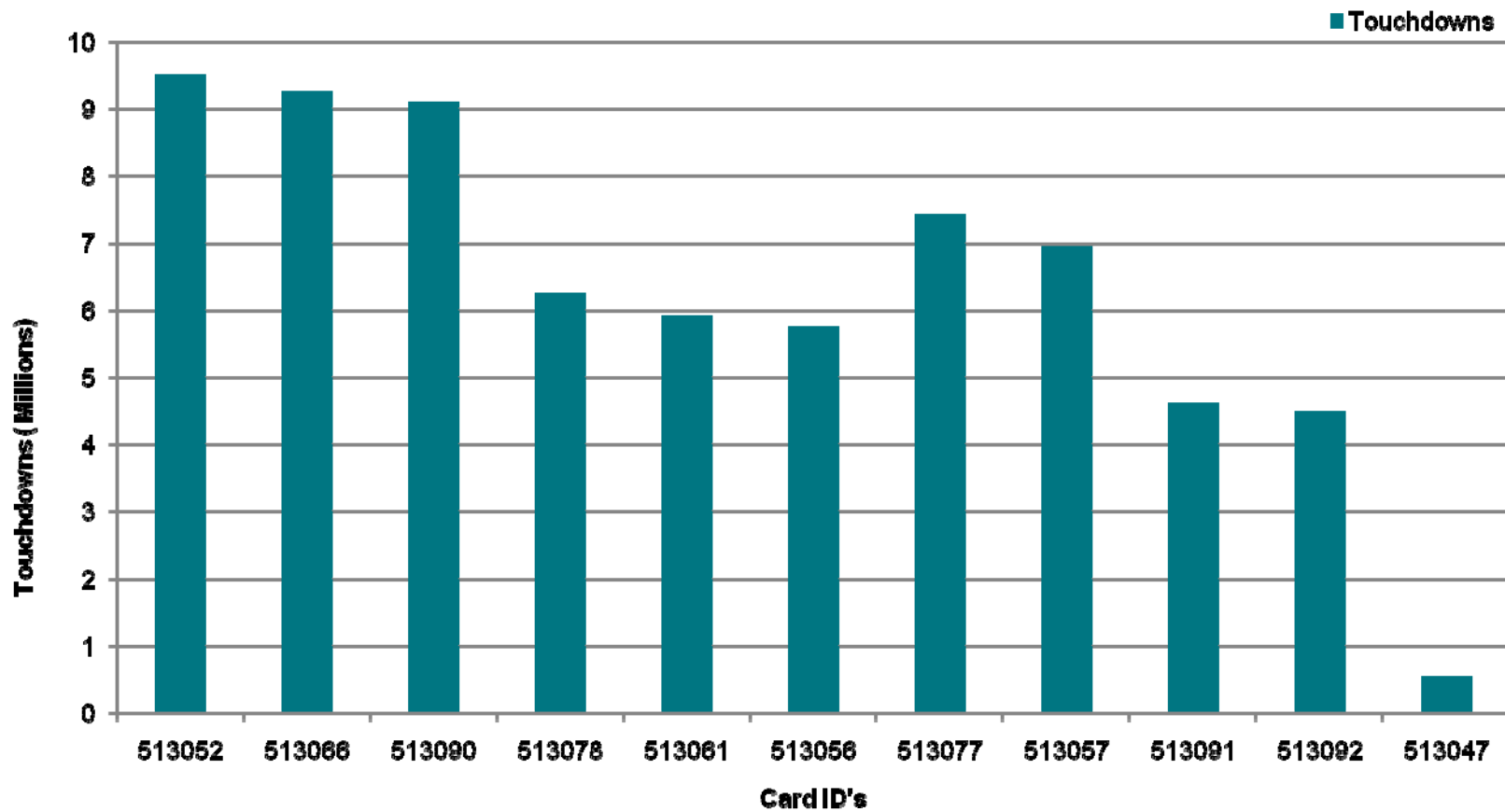


# Initial Findings on Cu Pads

1. Probe card incoming specifications reduced to  $<+-5$   $\mu\text{M}$  (no/limited metal memory).
2. Sort yield was same or slightly improved.
3. Sort retest levels reduced by 7%.
4. The number of wafers between analyser maintenance increased from 1 wafer to  $>4$  wafers.
5. Test time reduced by 4.5%.
6. The average contact resistance did not exceed 7.3 ohms (four wire to the pad.)
7. Average TDs increased to  $>5$ MTDs, (several cards have  $>7$ MTDs) an increase of  $>300\%$ .



# Current Production Card Lifetime

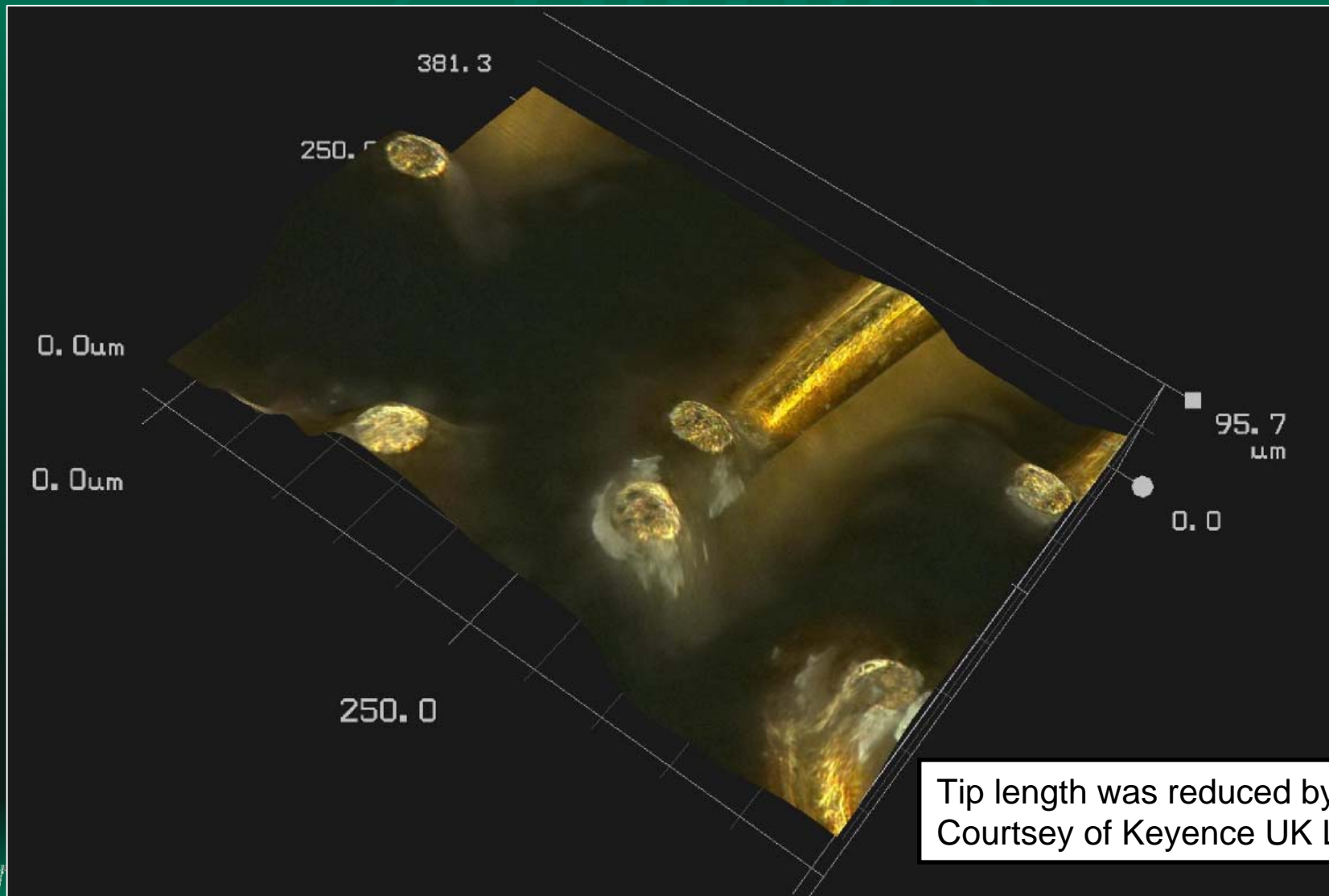


# Initial Findings on Au Pads

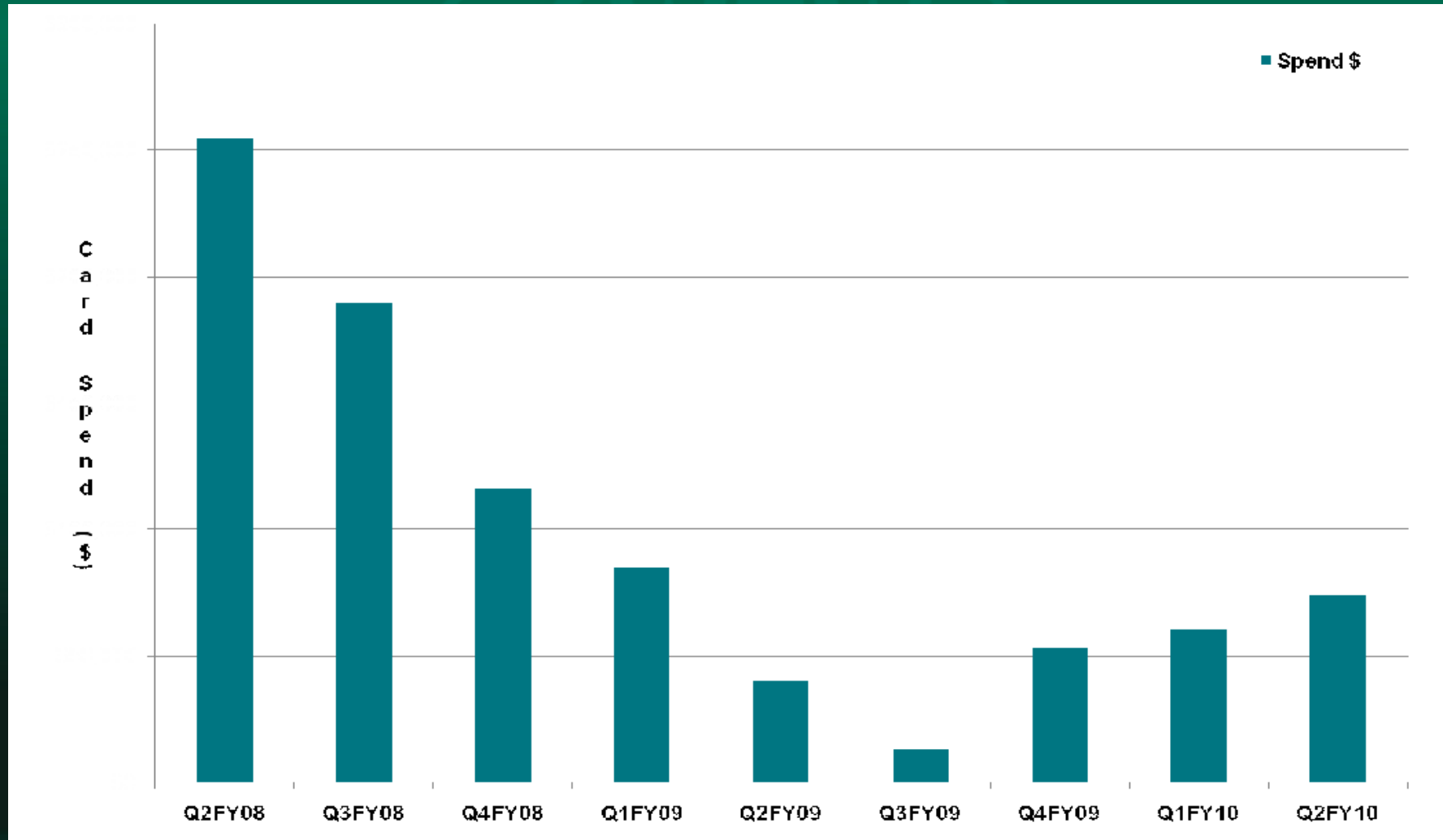
1. Probe card incoming specifications reduced to  $\pm 5\mu\text{M}$  (no/limited metal memory).
2. We had to change to Probe Scrub (3um Grit, ITS) to stabilise contact resistance.
3. The latter initially dramatically reduced the first tier, (7mil tip length), therefore we removed this on a specific area of the layout and we increased it to 14mil.
4. Sort yield was same or slightly improved.
5. Sort retest levels improved by 8%.
6. The number of wafers between analyser maintenance increased from 1 wafer to >4 wafers.
7. Test time reduced by 10%.
8. The average contact resistance did not exceed 7.3 ohms (four wire to the pad.)
9. Average TDs increase to >3MTDs an increase of 100%.



# 1st 8.5MTDs WRe Card



# Probe Card Costs (\$/QTR)



# Conclusions

- **A Great Results All Round**
  - Cost of ownership
    - Rebuild/repair reduction
    - Vendor cost reduction
    - Alignment & Planarity specification
    - Resource reduction
      - Prober & Analyser Efficiency Improvements
  - We can maintain a probe wire diameter of 8mils on our new products.



# Acknowledgements

- Jerry Broz, Ph.D., International Test Solutions
- Thanh Q Le, Mark Ferry, Seagate Technology Inc
- Guy Trolley, Keyence UK Ltd

## References

- **Advanced Probing Systems, Inc.**

